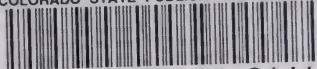


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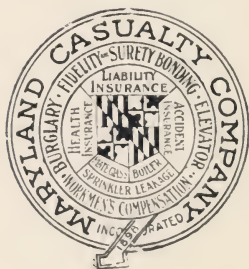


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THIRTEENTH BIENNIAL REPORT
OF THE
BUREAU OF MINES
OF THE
STATE OF COLORADO

1913-1914

No.



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The Cresson Mine, Cripple Creek, Where Big Gold Strike Was Made in December, 1914.

Thirteenth Biennial Report

OF THE

Bureau of Mines

OF THE

State of Colorado

T. R. HENAHEN, Commissioner

FOR THE

Years 1913 and 1914

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CONTENTS

	Page
Frontispiece—Cresson Mine.	
Personnel.....	5
Location of Districts.....	5
Letter of Transmittal.....	6
Foreword.....	7
Review of District No. 1, by W. H. Parenteau.....	13
Review of District No. 2, by Jas. T. Stewart.....	26
Review of District No. 3, by Jno. R. Curley.....	31
Review of District No. 4, by Sam'l Treais.....	42
Electricity and Mining, by C. R. Rudy.....	52
Arkansas Valley Lt. & Power Co., by W. F. Raber.....	57
Down Town Drainage, Leadville.....	60
School of Mines Experimental Plant, by Wm. G. Haldane.....	62
Mary Murphy Mill, by Geo. E. Collins.....	65
Atlas Mill, by Fred Carroll.....	71
Golden Cycle Mill, by John Tait Milliken.....	72
Colburn-Ajax Mill, by R. R. Bryan.....	75
Portland Mill (Victor), by Thomas B. Crowe.....	77
Mask Mill, by C. H. Hanington.....	78
Stratton's Independence Mill, by Phillip Argall.....	80
Argo Mill, by Ott F. Heizer.....	87
Barstow Mill, by C. R. Wilfley.....	91
Lombard Mill, by Henry I. Seemann.....	94
Mt. Champion Mill, by J. A. Becker.....	95
Carter Mill, by Carroll M. Carter.....	96
Primos Mill (Boulder County), by C. F. Lake.....	97
Smuggler Union Mills, by Buckley Wells.....	98
Empire Zinc Plant, by A. R. Livingston.....	100
Liberty Bell Mill, by W. E. Tracy.....	102
Smuggler Mill, by Chas. E. Anderson.....	104
Wellington Mill, by R. M. Henderson.....	106
Argo Tunnel, by Rens E. Schirmer.....	111
Radium Plant, Standard Chemical Company, by Jos. M. Flannery.....	113
Radium Industry.....	117
Tungsten.....	127
Gold Dredging, by Ben Stanley Revett.....	128
Precious Stones, by J. D. Endicott.....	132
Mica—Mining and Milling.....	135
Salida Granite.....	140
Colorado Yule Marble, by J. F. Manning.....	142
Turkey Creek Stone.....	145
Other Stone Resources.....	145
Cement.....	146
Clays.....	148
Asphalt—Gilsonite.....	149
Acid Manufacture.....	150

	Page
Conservation—Leasing.....	152
Colorado Mining Epitomized.....	156
Colorado Metal Mining Association.....	159
Legislation.....	166
Geology of Colorado.....	173
Geological Folios.....	176
Mining Districts of Colorado.....	177
Labor Troubles.....	183
Accidents.....	184
Accident Tables.....	186
Men engaged in mining, milling and smelting.....	188
Employees above and underground.....	190
Safety recommendations.....	191
Instructions for resuscitation from electric shock.....	192
Don'ts.....	196
Code of signals.....	198
Financial statement.....	199
Metal production 1913—table.....	200
Metal production 1914—table.....	202
Total metal production of Colorado.....	204
Average market value of metals.....	206
Mining Laws.....	208
Altitudes of cities and towns.....	215
Altitudes of peaks and passes.....	216
Altitudes of parks and lakes.....	220
Population of Colorado.....	221
Gold strike, Cresson Mine.....	222

PERSONNEL OF THE BUREAU OF MINES OF THE STATE OF COLORADO

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JOHN R. CURLEY, Inspector District No. 3.....Leadville
SAMUEL TREAIS, Inspector District No. 4.....Montrose
JOHN M. O'CONNELL, Chief Clerk and Assistant Curator, Denver
MRS. A. M. NICKERSON, Stenographer.....Denver

LOCATION OF DISTRICTS

- DISTRICT No. 1—Denver, Jefferson, Boulder, Larimer, Jackson, Routt, Grand, Gilpin, and Clear Creek Counties; known and designated as the Georgetown District.
- DISTRICT No. 2—El Paso, Teller, Pueblo, Las Animas, Huerfano, Custer, and Fremont Counties; known and designated as the Cripple Creek District.
- DISTRICT No. 3—Lake, Summit, Chaffee, Park, Pitkin, Mesa, Delta, Eagle, Rio Blanco, and Garfield Counties; known and designated as the Leadville District.
- DISTRICT No. 4—San Juan, Ouray, Hinsdale, Mineral, Rio Grande, Saguache, Costilla, Conejos, Archuleta, La Plata, Montezuma, Dolores, San Miguel, Montrose, and Gunnison Counties; known and designated as the San Juan District.

LETTER OF TRANSMITTAL

To His Excellency,

ELIAS M. AMMONS,

Governor of Colorado.

Sir: As provided in section 4268, Revised Statutes of 1908, relating to "Bureau of Mines—Mine Regulations," I have the honor of submitting to you herewith the thirteenth biennial report of this department.

Respectfully yours,

T. R. HENAHEN,

Commissioner of Mines.

Denver, Colorado, December 15, 1914.

Foreword

It has been the plan heretofore to include in the report of this department the two calendar years of the period covered. However, the fiscal year of the state closes on November 30, and it has been thought best to bring this report to that date only. One of the principal uses of the reports of departments is to advise the General Assembly of the work that is being done. The legislature meets in January, and it is therefore obvious that a report embracing the full calendar year cannot be printed and published in time to serve the purposes of the legislature.

A blank space is left in this report for the insertion of a table showing the mineral production of 1914. These data cannot be obtained until the close of the calendar year and usually are not ready until February 15. The table will be printed later and delivered to persons receiving this report to be inserted in its proper place.

Written reports of accidents do not always reach the department for several days after the accident. We have therefore included only those accidents which occurred prior to November 30, 1914. Hereafter the tables analyzing accidents can be made to correspond with the fiscal year of the state.

ACKNOWLEDGMENTS

The thanks of the Bureau of Mines are due to national and state institutions and departments which have co-operated with us in various ways; to the press of this and other states, for free copies of their publications; to the mine operators of the state, who have displayed a willingness, not only to obey the laws relating to the operation of mines, but to co-operate with this department in every practical way; to the contributors of articles to this report; and to the inspectors and office force of the department, for faithful and efficient services.

COAL AND OIL

The coal mines of Colorado are under the jurisdiction of the State Coal Mine Inspector, and the oil wells under the jurisdiction of the State Oil Inspector. These departments are not connected with the Bureau of Mines, but have offices in the State Capitol.

MINERAL WATERS

A comprehensive report on the mineral springs of Colorado is being prepared by the State Geologist, R. D. George, and will soon be ready for publication.

PROGRESS OF LAST TWO YEARS

The years 1913 and 1914 witnessed a marked improvement in the condition of the metal-mining industry in Colorado. Several rich discoveries were made in new districts, the development of the older mines continued apace, and prospecting had not been conducted so vigorously in any similar period for the last twenty years. A better feeling was created among mining men and the citizens of the state generally.

Capital, after years of wandering in less profitable fields, had begun to smile again upon the miner, and the mining machinery houses of the state were rushed with orders, when the war cloud settled over Europe. The immediate effect of the war was a slump in the price of silver, lead, zinc, and copper, and the destruction of the market for radium. A week after war was declared it was feared that nearly all the mines, except those in which the predominant metal is gold, would be forced to close until the market settled.

Fearful that the war would materially reduce the demand for silver and that buyers of the metal might have their capital tied up for several years, the smelters announced that they would buy silver ore only with the understanding that the miner would receive twenty-five cents an ounce at the time of sale, and later, when the market reopened, he would be given the balance of the market price then prevailing. As many mines of Colorado are operated on a close margin of profit, and especially since the price of lead, zinc, and copper dropped simultaneously, the situation became serious.

Colorado and other western mining states appealed to Congress. A bill was introduced, providing that the government buy enough silver, at the average price paid in 1913, to keep the mines operating for several months. The effect was electrical. Immediately the silver market was restored to nearly its former level. The zinc, copper, and lead markets have not improved satisfactorily, however, because the European countries now at war are the largest consumers of these metals.

The ill effects of the war upon the mining industry already have been experienced, and the miner is now preparing himself to meet the reaction which will occur when peace has been established. I fully believe that when the war is over the mining industry of this country will be gloriously triumphant. The world must look to us for minerals during the European reconstruction period, and we shall have to work our mines to their capacity to supply the demand made upon us.

When we consider the enormous financial cost of the war, not only in money expended for the maintenance of armies in the field, but for the restoration of industry; when we contemplate the enormous debts of the warring nations, we conclude that the scarcest article in the world will be coin. The gold will not be sufficient to meet the situation. The nations, we believe, will



Getting Out the Ore—Underground Scene.

be forced to accept silver. Therefore it will not be at all surprising if a demand is made for international bimetallism. One who recalls the former glory of our mining camps, before silver was dethroned, can appreciate what this will mean to Colorado and other silver-producing states. Nearly all abandoned silver mines in the West will be reopened. It should mean the rejuvenation of our mining camps, a vast increase in population, and a greater prosperity than the West has ever known.

NEED OF MANUFACTORIES

If, in the meanwhile, the people of this state will give proper encouragement to manufacturing, Colorado will take its place as one of the leading industrial states of the Union. We have all the necessities for manufacturing—raw materials, coal, water, and power. We lack only a public spirit. European scientists and manufacturers, who occasionally wander as far west as Colorado, are amazed at the wealth of our resources and wonder why the people of this state are not more fully awake to their advantages. Practically all manufactories established in Colorado, that have been based on the raw mineral products of the state, have been successful. Indeed, our resources must inspire everyone who has explored the state, not merely by looking from a car window, but by actual contact.

MORE PROSPECTING NECESSARY

Colorado never had a greater opportunity than that which now presents itself. There is nothing that would quicken the business life of the state as would the discovery of a new mineral district, such as Cripple Creek, Leadville, Creede, or any of the other camps which became famous in the earlier days. It is not idle talk to say that Colorado has scarcely scratched its mineral resources—it is a proven fact. Geologists point to great areas in which no prospecting has been done, and to other well-beaten paths where prospecting of another type than the miner's pick must be pursued. We can have the new camps if we will give proper encouragement to prospecting.

For example, the United States experts declared that our radium resources were being exhausted, and the cry arose that we must shut the prospector out of our radium fields. The result was that, while Congress was deliberating over the matter, the prospectors, spurred on by a desire to locate a claim before the ax fell, discovered carnotite (radium-bearing) ore in eight counties of this state in less than six weeks, where it was never known to have existed.

We can make the rush for gold, silver, and other metals equally alluring, if we but give proper encouragement to prospecting; and it is the duty of the state to do it.

I urge upon the General Assembly the necessity of giving heed to the demands of the metal-mining industry. Upon its success depends the prosperity of Colorado.

NEW CAMP AT EAGLE

Early in the spring of 1913 a big strike of silver ore was made in Eagle County, in the district lying between the towns of Eagle and Fulford. The strike was made in the Dakota sandstone—a formation which had not been looked upon with favor by Colorado miners.

Soon the whole country around was staked with claims, many being located on the top of a blanket of four feet of snow which covered the ground at that season.

The original discovery was made on the Lady Belle claim, which has since been developed to a depth of 200 feet. The ore ran in values from 60 to 900 ounces silver. As depth was attained, the values decreased, and it was necessary to suspend operations until a mill can be built. The North Dakota also gives promise of being a producing mine, but it is in the prospect stage.

As nearly as can be ascertained, ore valued at \$250,000 was shipped out of the district since the original discovery in 1913.

EXCITEMENT IN CONEJOS COUNTY

Following the Eagle strike, there was renewed excitement in Conejos County, in the districts near Stummer, Platoro, Jasper, and Gilmore. High-grade gold ore was found in several properties; but the camps are low-grade, and mills will be necessary before big productions can be made. These camps also were the scenes of excitement during the summer of 1913.

I believe both the Eagle County and the Conejos County districts will be large producers when sufficient development work has been done.

Early in 1914 there were numerous discoveries of carnotite ores in widely scattered territory. Discoveries were made in Routt, Moffat, Rio Blanco, Huerfano, Eagle, Lake, Park, and Fremont Counties, indicating that this ore is spread over a wide territory in Colorado and that this state will remain one of the greatest producers of radium. Radium-bearing ores also were found in several other states.

MOLYBDENITE

Molybdenite ore was discovered in Summit, San Juan, and Clear Creek Counties. The Clear Creek properties are being developed extensively.

PITCHBLEND

Pitchblende ore, which heretofore had been confined to Gilpin County, where it was first discovered in this country, was found, in 1914, in the Jo Reynolds Mine of Clear Creek County. This ore contains a high percentage of uranium—the metal from which radium is produced.

SMELTERS

The American Smelting and Refining Company operates plants at Denver, Leadville, Durango, and Pueblo. There are two smelters at Pueblo, owned by this company, one of which is devoted to the treatment of zinc.

A new pyritic smelter was blown in at Ouray to treat ores of that district, and a zinc smelter was blown in at Leadville to treat the low-grade carbonate ores.

The Ohio and Colorado Smelting and Refining Company operates a large plant at Salida.

Several new metalliferous mills were erected in 1913 and 1914 along the most advanced metallurgical lines.

A more detailed review of activities in the various mining counties will be found in the chapters devoted to the inspectors' districts.



Showing Vein of Pitchblende Ore in a Gilpin County Mine, 800 Feet Underground.
The Miner is Operating a Machine Drill.

Review of District No. 1

By W. H. PARENTEAU, Inspector

The total production of gold, silver, and other precious metals for the year 1914 in District No. 1 is not available at the time of writing this review. It will, no doubt, show a marked improvement as compared with the year 1913, which was less than 1911-12, regardless of the falling-off in production for a time, due to the excessive and unprecedented amount of snow during the year, beginning with December, 1913, which later caused a large flow of water in the mines during the spring and summer months.

For the year 1913 Boulder County, on account of greater demand and better prices for tungsten, was the only county in the district that showed an increase in production over the preceding year. Clear Creek County, because of the increased activity in the Newhouse and Big Five Tunnels, did not fall much below the two previous years either in production or in the number of men employed. Gilpin County produced slightly less also during the same period, on account of the closing-down, during the latter part of the year, of the Frontenac-Adduddell and Topeka Mines, three of the largest producers in the county. The output from Gilpin County may be decreased during 1914, on account of the closing-down, through litigation, of the East Nottaway Mine, which is one of its oldest and largest producers; also, for the same reason, the German-Belcher group, famous for its pitchblende ore, ceased active operations during the year. Other groups not in litigation, but situate in the pitchblende district, are now working for the gold values only, which means below their full capacity.

The recent and renewed activity in numerous sections of all the counties comprising the district is very encouraging and will add a material increase to the production of the precious metals during the next few years.

GILPIN COUNTY

Mining in Gilpin County is carried on principally for the gold values in the ore, and the greater part of this industry during former years was confined to an area not exceeding two miles square; or, immediately south of Central City and Black Hawk. Three-fourths of the county's area lies north and west of the two towns mentioned, and the silver belt, which is fairly distinct, occupies the northeastern limit of the county. While silver commanded a good price the northeastern section of the county was worked extensively for this metal. In the gold belt of the county

the ores contain an average proportion of about five ounces of silver to one ounce of gold, and add largely to the total output. In the northern part a large area is only slightly developed, but recent operations by several companies have proven that this section of the county carries good values and has a definite future.

The veins of Gilpin County are true fissures, and are mostly iron sulphides and quartz carrying gold, silver, copper, lead, zinc, tellurium, tungsten, and uranium. About 20 per cent of the ore bodies is refractory, but the balance of the vein filling is free-milling and concentrating, which is usually treated by the amalgamating process. The mineral area of the county has two distinct sets of veins: one set has a course northeast and southwest, and the other set is east and west; but both are similar in other respects.

The deepest mine in the county is the California Mine, which has a shaft 2,230 feet in depth. This, and other lodes of a similar character that have been mined to any extent, prove that the values are continuous with depth. At the present time many of the principal mines within the limits of Gilpin County are worked through the Argo Tunnel, formerly known as the Newhouse Tunnel, which is driven from Idaho Springs at an average depth of 1,800 feet, and the ore values of these mines are found to be of a better grade than found nearer the surface.

The average value per ton of ore mined in Gilpin County during the two years just ending is higher than for several of the preceding years. The shipments of ore and concentrates via the Colorado & Southern Railroad at Black Hawk for the year 1913 (1914 not yet obtainable) amounted to 1,800 cars and weighed 45,000 tons. To this should be added 30,000 tons mined through the Newhouse Tunnel at Idaho Springs and shipped from that point, and at least 1,500 tons from the northern part of the county shipped over the Moffat Railroad. The thousands of tons of mill ore and concentrates treated in the several mills and concentrating works of the county are not included in the above figures. To the gold-bearing ore should be added about 400 tons of high-grade pitchblende ore that was shipped from the Central City depot and estimated as worth \$150,000.

During 1913-14 a number of mines inactive for years have been cleaned out, retimbered, and newly equipped with up-to-date electric machinery. Some of these are worked entirely under the leasing system, with satisfactory results for both the operators and lessees, and give employment to a large number of men who would otherwise be idle. The Colorado Carr Mine on Bobtail Hill, operated through a shaft over 1,000 feet deep, began active work in January, 1914, under the leasing system, and has employed an average of forty-five men since starting. The old steam plant of machinery has been replaced with modern electric equipment, which includes a compound Berry electric compressor and a 50-H.P. motor to operate the machine drills. The shaft and levels have been retimbered and placed in excellent shape preparatory to extensive operations. Some of the drifts newly extended

have opened up large bodies of good concentrating ore and smelting ore of exceptionally high values in gold and copper. This company has recently constructed a mill at Black Hawk, which is equipped with all the newest and labor-saving ideas for milling low-grade ores. Before the close of 1914 this mill will be in full operation, and the tonnage from this property will then be largely increased.

The Barnes group of mines on Quartz Hill, owned and operated by the Cleveland and Central City Mining Company, was greatly hampered in its operations during the heavy storms of last winter, on account of lack of transportation. This company has spent much time and money in repairs and reconstruction, in its effort to make this one of the best mines in the county. The ore shoots have increased in length and width as depth is gained, the vein on the 600-foot level being 8 feet to 10 feet between walls, and includes both concentrating and smelting ores of good values. Because of the present low price of copper and silver, little ore is shipped and work is confined to development. The ore is automatically dumped into the cars of the Gilpin tramway, and the cost of handling and transporting is reduced to a minimum. This is one of the best-developed mines in the county and should be a large producer in the near future.

The Pittsburg group, owned by the Cashier Gold Mining and Reduction Company, is operated through a shaft 1,050 feet in depth. This group is situate at the foot of Nottaway Mountain, and is noted for its abundance of high-grade gold and copper ores. During the last fourteen years this mine has a record of an average monthly production of 100 tons of ore, 85 per cent of which is smelting ore of a very high grade. The surface equipment is fine, and both steam and electric power is employed. A large force of men is regularly employed in breaking ore and doing continuous development work.

The Sayre-Bates Mine, situate within the corporate limits of Black Hawk, was located during the early sixties, but was worked at irregular intervals by different companies, with varying success, until the present lessees began operations early in 1912. Large bodies of ore were encountered, but on account of its low grade the results were only partially successful with the old methods of treatment. Early in 1914 the old Horn concentrator in Black Hawk was fitted up with modern extraction methods, and all of the mill ore is now treated by this process and gives very satisfactory results.

In the northern part of the county and six miles from Central City is the Pine Comb Mine, which is situate in the Hawkeve district. This is operated through a tunnel 1,100 feet long which intersects several veins of a high-grade gold ore. A shaft on the Pine Comb vein is 200 feet deep and shows continuous ore to the bottom. Last summer a thirty-ton amalgamating and concentrating mill was erected at the portal of the tunnel, which gives a saving of gold contents as high as 80 per cent of the assay values.

Two miles northwest of the Pine Comb Mine is the Golden Flint group. It is about four miles from Rollinsville on the Moffat Railroad, with good wagon-roads connecting. This property has a fine record as a producer of high-grade ore, and in addition has a large supply of the lower-grade ore. Recently a new mill was constructed, and is now operating on the low-grade ores at the rate of 100 tons daily. This mill is specially constructed for the treatment of sulphide ores by amalgamation, concentration, and cyanidation. It is claimed the mill saves from 90 to 92 per cent of the values. Twenty-five to thirty men are regularly employed in the mine and mill.

The London Mine, up Twelve-Mile Gulch, has been developed by a shaft 200 feet deep and with several laterals each way. Unusually fine veins of gold and silver ore, and of high grade, are found in this mine, and the values improve in depth. The property is equipped with a steam hoisting plant and a ten-stamp mill, and the average number of men employed is fifteen.

A number of mines in the same vicinity of the London Mine are actively engaged in adding to the county's production, one of the most promising being that of the Pennsylvania-Colorado M., T. and M. Co., near Apex, where much development has been done and many improvements made, including a new ten-stamp mill. The tunnel is 1,000 feet long, and 400 feet of drifts have been run that show good bodies of ore.

At the Saratoga Mine, in Russell Gulch, a new mill has recently been erected for the treatment of the ores in the dump and in the stopes of the mine, which is estimated at 200,000 tons of material that will average \$4 per ton in value and can be treated at an expense of \$1.50 per ton. The process is a combination of cyanidation and amalgamation. The originators claim that it is the solution of the treatment of low-grade sulphide ores in Gilpin County, and the result will be watched with interest by other mine-owners with properties of a similar nature.

Radium Ores

It is well known that the earliest discoveries of radium-bearing ores were made in Gilpin County, and, according to experts, the mines of this county are among the very few high-grade pitchblende deposits in the world. The extent of the radium district was originally believed to be about eighty acres, extending from the German and Belcher Mines on the north to the Jefferson-Calhoun Mine on the south. Recently it has been proven that this estimate is wrong, and the known area, taking the German Mine as a center, extends for a number of miles in all directions. Convincing proof of this is given by the recent discovery of high-grade pitchblende ore in the Quartz Mill Mine east of the original area, and in the Jo Reynolds Mine which is situate about five miles southwest of the German Mine.

The ore bodies of a high grade of pitchblende ore are usually low in gold values, but the Calhoun Mine is a notable exception

to this rule. A very high grade of uranium ore is found in this mine, and next to the uranium streak are copper pyrites running fifteen ounces of gold to the ton, and about four feet of good mill ore running well on the plates.

The radium ores have temporarily lost their values on account of the European war. The pitchblende ore last taken from the Wood, German, and Belcher Mines was shipped to Denver during March, 1914, and is still held in safety vaults in that city. The total value of this ore is estimated at not less than \$150,000, and it weighs about 350 tons. Something like \$6,000 in gold was produced from these mines during 1913. All work for 1914 has been confined to gold ores only.

A healthy revival in mining is shown in all of the outlying districts of the county, and extensive operations are under way, not only in these districts, but in many of our oldest mines nearer the center of the county. The old mines were worked from the surface through shafts, and produced many millions of dollars of gold; but, as depth was gained, the flow of water was so excessive that the profits of mining were gradually but steadily reduced, and the owners were at last compelled to stop operations altogether. The Newhouse Tunnel has solved this problem, as evidenced by the new and extensive work now done on such famous mines as the Gunnell, Concrete, Dyke, and Kansas-Burroughs groups, all of which are now worked through the tunnel and are disclosing larger and richer bodies of ore, at a depth of 1,800 feet to 2,000 feet, than were found on the surface.

CLEAR CREEK COUNTY

Clear Creek County showed a decrease in ore production for the year 1913 as compared with 1912. This was principally due to the decrease in zinc production from the Silver Plume district, the difference being 179,449 pounds, and the smaller price received per 100 pounds of spelter, which was \$5.60 instead of \$6.81 as in 1912. About one-fifth of the total values of all the metals produced in 1913 was taken from the Georgetown and Silver Plume districts, but was mostly silver, lead, and zinc, while the remainder of the county's production is credited to the district which includes Idaho Springs and vicinity, where a number of high-grade gold-copper mines were started up during the year. The total production for the year was \$1,004,726, according to the United States Geological Survey; and the year 1914 will show a considerable increase over the previous year, as more and richer mines have been producing in the last twelve months than for several years previous.

In the Daly district, and about eight miles west of Empire, systematic work was begun on Red Mountain by the Primos Chemical Company, with main office at Primos, Pa. This district has been noted heretofore for its silver-lead ores, but the work on Red Mountain is for the purpose of developing the molybdenite veins, of which there are several on this property. It is claimed

that the crude ore averages 15 per cent in molybdenum, in addition to the silver-lead values. If what is claimed stands the expert test, the rare-mineral output of the state will be greatly increased, as the entire surface of Red Mountain shows numerous veins of a similar formation. The property is being developed through a tunnel, and extensive surface improvements have been completed, ready for continuous work during the winter months. Several carloads of the ore have been shipped to Pennsylvania for expert treatment, and the result of this test is expected to confirm previous tests.

Until quite recently the pitchblende area, which has attracted world-wide attention, was believed to be confined to a small section of Gilpin County. This has been proven a mistake, as this rare and valuable mineral has been found in considerable and paying quantity in the Jo Reynolds Mine, situate near Lawson in Clear Creek County and about five miles distant from the radium-producing mines of Gilpin County. How much farther the field extends in this direction must be left to future discoveries.

The Jo Reynolds Mine has been a large producer of gold-silver ores since its early location in 1865, and has produced not less than 15,000 tons of high-grade ores. Over 15,000 feet of development, consisting of shafts, tunnels, drifts, etc., has been done. After such a long period of almost continuous production this mine is still relied upon to add its quota of precious metals.

The Argo, or Newhouse, Tunnel has its beginning within the corporate limits of Idaho Springs. It penetrates Seaton and Pewabic Mountains, Quartz Hill and Gunnell Hill, crossing under the county line into the Central City district, and has its terminal under Prosser Mountain. About three-fourths of the tunnel is situate in territory included within the limits of Gilpin County, and intersects the mineral veins at an average depth of 1,700 feet. It is the longest straight mining tunnel in the world that is in active operation, and was driven for the transportation and exploration of ores, in addition to draining an estimated area of ten square miles. The tunnel is 22,000 feet long and cost on an average \$20 per foot to drive it. The first 11,000 feet is 10' x 10' in the clear, and the balance is 5' x 8' in the clear. Part of the tunnel is double-tracked, and electric locomotives are used for hauling ores and waste rock, which are dumped automatically.

The mines worked through the tunnel are as follows: Gilpin-Pozo, Old Town, Gem, Golden Edge, Sun and Moon, Seaton, Kansas-Burroughs, Concrete, and Gunnell. The Concrete and Gunnell Mines are situate at the extreme end of the tunnel and are worked under the management of the tunnel company. In a stope of the Golden Edge Mine a body of ore was opened that was found to be phenomenally rich in gold and silver. Assays gave returns as high as \$32,000 per ton, and five cars of a poorer grade yielded approximately \$10,000. Early in 1914 lessees on the Gem Mine, which was the first producer of ore in the Argo Tunnel,

opened up a fine body of high-grade sylvanite ore, and with it two feet of good smelting ore. The tonnage has been large, and the indications are that shipments will continue indefinitely. Another set of lessees on the Gem Mine, known as the Coe lease, have been producing fifty tons of ore daily for two years. The net profits for one year from this lease were about \$45,000. In the Sun and Moon Mine extensive development has been done at a depth of 2,000 feet, and the ore bodies are increasing in size and richness as new ground is opened. A streak of bornite ore that is seven inches wide and worth \$100 per ton was reported from this mine by the lessees. The mines now operated through the tunnel are giving such good results that numerous other veins intersected by the tunnel are receiving serious consideration from their several owners.

The Argo Mill, situate 300 feet from the portal of the tunnel, is run by electricity, has a daily capacity of 100 tons, and is running to full capacity on ores taken from the tunnel. The mill is a cyanide process and saves an average of 94 per cent of the assay values. The mill is a simple and practical method of concentrating the sulphide ores of the district, and is giving most satisfactory results. The ore is first crushed and concentrated, and the high-grade concentrates, which are small in quantity, are sent to the smelter. The greater part of the concentrates are middlings, are ground very fine in a tube mill, and then both middlings and slimes are carried to the agitator and agitated with a cyanide solution, the gold being then precipitated from this solution on zinc shavings.

Big Five Tunnel

The Big Five Tunnel is another transportation and drainage enterprise that starts from the west end of Idaho Springs. The tunnel has a northerly direction and has been driven a distance of 10,000 feet. It will intersect the Old Town Mine near the shaft, and will, when completed, cross the Argo Tunnel under Quartz Hill. Eleven veins have been cut by the tunnel, but active work is confined to the Lake and Belman veins up to the present time. The Lake Mine, owned by Hal Sayre, of Denver, is intersected at a distance of 8,346 feet from the portal of the tunnel and to a depth of 2,300 feet on the dip of the vein from its apex. About 1,500 feet of laterals have been driven that have opened large bodies of a good grade of ore. Blocks of ground are worked by three sets of leasers, and 600 to 1,000 tons of ore are produced monthly. A lateral is being driven on the Belman vein to undercut the Dove's Nest vein which lies 1,200 feet east of the intersection of the Belman vein and the tunnel. Continuous ore bodies have been found in the Belman lateral, but are of a low grade. Transportation through the tunnel is by means of the Edison storage battery, traction system, and was installed in 1911.

Wilcox Tunnel

Nine miles west of Georgetown, in the Argentine district, is the Wilcox Tunnel group, consisting of about 600 acres of patented and unpatented claims. There are over 100 known veins included in this group, which lies mostly on the east slope of Mount McClelland, at an altitude of 10,000 feet. The Argentine Central Railroad passes within thirty feet of the portal of the tunnel, and a good wagon-road is built from the mine to Georgetown. This group has been a large and regular producer of gold and copper ores of a high grade for the greater part of the time since its earliest history, dating from 1864. Work has been confined principally to the Commonwealth and Paymaster veins, with over 15,000 feet of development done upon them. Only the smelting ore has been shipped for the last two years, and the concentrating ore, of which there are thousands of tons, is left in the stopes for future treatment in the company's mill. This mill is being remodeled and as soon as completed will at once begin treatment of the low-grade ores.

Santiago Tunnel

One mile northwest of the Wilcox group the Santiago Tunnel is situate, near the summit of Mount McClelland and at an altitude of 12,000 feet. The ores from this mine are conveyed, by means of an aerial tram, a distance of one mile to the yards of the Wilcox Tunnel, and are there dumped automatically into the cars of the Argentine Central Railroad for shipment. This property has been worked continuously since 1898, and has been a regular shipper of high-grade gold-copper ores.

Many other properties throughout the county are actively engaged in adding to the annual production of the district, but further description is needless for the present purpose. The mills and concentrating works include the best and most modern ideas in treatment of low-grade ores, and are generally satisfactory.

BOULDER COUNTY

Boulder County leads the world in its number of rare metal mines. The gold, silver, and other metal values maintain a good annual average, but tungsten during recent years has furnished three-fourths of the annual production of the precious metals of the county, although the demand for this metal is largely controlled by the activity in the steel trade. For the year 1913 Boulder County produced about \$700,000 in tungsten concentrates, and \$189,330 in gold, silver, and other metals. During three months of 1914 the demand for tungsten was lessened on account of the decrease in steel manufactures, but the demand is now slightly increasing, although the price remains the same. The lower price for the metal has caused many of the small producers of tungsten to close down temporarily. The snow blockade in January and February caused a decrease from several

of the districts at the time, but this was more than made up later in the year by unusually heavy shipments. The total for 1914 in tungsten may be less, but in gold, silver, and other metals the year's returns will be much larger than for many years previous, on account of the resumption of work on a large scale of several of the largest and oldest mines in the Grand Island district. Besides the large mines, numerous small ones are again producing gold-silver ores, are self-sustaining, and form an important part in the revival of mining in Boulder County.

The old Caribou group, which from 1872 to 1880 supported a population of nearly 10,000 and was famous for its silver-lead mines, has again become prominent in mining circles and is now worked for its gold values in addition to its silver and lead. The Cariman Mining and Milling Company during the latter half of 1913 began operations on the Caribou group, which includes the Caribou, Poorman, and No Name Mines, and is situate two miles northwest of the Boulder County Mine at Cardinal. The last-named mine is operated by the same company through a tunnel that is 3,200 feet in length and has 2,000 feet of drifts. Active operations were started in February, 1914. The tunnel and drifts have been placed in excellent condition, and a large amount of stoping is carried on, so that an average of fifty tons of concentrating ore is produced daily. It is the intention of the company to run a cross-cut of about 7,000 feet from the tunnel to intersect the veins of the Caribou group, and when completed the tunnel will then drain this territory and greatly reduce operating expenses of the Caribou group of mines, which are unusually wet.

At the Caribou Mine a new 100-ton cyanide mill has just been completed which will treat the low-grade ores from the mine, as also the enormous amount of material in the dumps that average \$6 in value to the ton and can be treated for about \$1.50 per ton. The ores from the Boulder County Mine are treated in the 35-ton amalgamating and concentrating mill situate at the mine. A good saving is made with this mill.

In July, 1913, the Cold Spring property, that had been idle for years, was started up by the Gold Hill Mining Company. This group is situate on the north slope of Gold Hill and is about one mile above Rowena on Left Hand Creek. During its early history it was one of the largest producers of tellurium and free-milling ores in Boulder County. Nearly 20,000 feet of development has been done, and a large part of the ore bodies still remains in the mine that can now be mined and treated at a moderate cost. The average monthly production of ore is 1,500 tons, which is mined at a cost of .90 cents per ton, transported to the mill for 18 cents per ton, and treated for \$2 per ton. The average value per ton of ore is \$10, and there is enough ore in sight in the mine to keep the mill running for several years. To treat this ore the company has just completed a 100-ton cyaniding and concentrating mill of the most modern type, and will operate it to its full capacity.

Tungsten

The three largest tungsten-producing companies are the Boulder Tungsten Production Company, the Wolf Tongue Company, and the Primos Mining and Milling Company, all operating in the Grand Island mining district. The three companies employ an average of eighty-five men in regular production of ore. Some of the men are working under the leasing system. The Wolf Tongue Company treats its own production in a concentrating mill of fifty tons' capacity, situate in the town of Nederland. The 100-ton concentrating mill of the Primos Mining and Milling Company is three and one-half miles north of Nederland. This mill runs to its full capacity on company ore, and saves an average of 90 per cent of the assay values. Ten tons of crude ore are concentrated into one ton, and the average value of concentrates is \$600 per ton, carrying principally tungsten values. The mill is equipped with ten quick-drop stamps, tube crusher for regrinding, eleven frue vanners, two Wilfley tables, and three sets of inclined canvas tables of twenty tables to each set (first set of tables twenty-four feet long, second set sixteen feet long, and third set twelve feet long).

Fluorspar

The large ledge of fluorspar on the summit of a mountain one-half mile distant from the town of Jamestown is still furnishing its regular supply of 3,000 tons to the steel works at Pueblo, and commands the same average price of \$6 per ton. This industry has given regular returns for a number of years, but is not included in the statistical tables of the county.

The ore shipments from Boulder County for 1914 are at least 25 per cent higher than they were for 1913. This fact and the heavy shipments of mining machinery, coal, and other supplies to the several mining camps, especially west of Boulder city, are sufficient proof of a genuine renewal of mining activity throughout the county.

ROUTT COUNTY

Routt County, agriculturally speaking, has many natural resources, but they are only partially developed. The same may be said of that part of the county—about one-third of its entire area—where its only production is the result of metal-mining. Only about 10 per cent of its mineral resources have been partially developed, although the prospects for successful mining are excellent. Since the extension of the Denver & Salt Lake Railroad more work has been done in Routt County, exceptionally rich in minerals, than in all previous years. Even with the advent of the railroad, much of the work outside of the Hahn's Peak district has been confined to prospecting, owing to a lack of facilities for treatment. The cost of transportation is \$18 per ton from Hahn's

Peak to Steamboat Springs, a distance of thirty-five miles, and thence via the Moffat Railroad to Denver, which is the nearest point where public works are located. This is absolutely prohibitive, even with the richest of the ores.

Previous to 1912 the only metal returned in Routt County was gold, and the total product amounted to about \$2,000,000, which was taken from placers on the south side of Hahn's Peak. For 1913-14 the annual production is about \$3,500. This amount includes gold, silver, lead, and copper produced, and is confined almost entirely to lead-mining. Six miles east of Hahn's Peak a dredge was placed on Willow Creek during the latter part of the summer of 1914, and preparatory work for placer mining was done at that time.

The only property extensively developed is the Royal Flush group, situate on the west slope of Hahn's Peak, at an altitude of 9,700 feet. It has been developed by two tunnels, 953 feet and 2,200 feet in length, respectively, but all work is confined to the longer tunnel, which is driven its entire length through a conglomerate mass of quartz and porphyry. At a distance of 900 feet from the portal of the tunnel the Contact vein is intersected, and some drifting has been done on the vein, which is four and one-half feet in width. The vein filling is iron sulphides, porphyry, and a black decomposed matter of volcanic character carrying gold, silver, copper, lead, and zinc, and with an average value of \$35 per ton. Beyond the Contact vein a number of veins, similar in character, and a large porphyry dyke twenty feet in width and of low value, are intersected by the tunnel. The average value of the veins, not including the Contact vein, is \$14 per ton, and the monthly production is 100 tons.

Practically all of the ore of this group is concentrating, and is treated in the recently completed 100-ton concentrating mill situate 250 feet from the portal of the tunnel. The mill building is three-terraced, frame covered with rubberite and 45' x 70' in size, and equipped with 50-H.P. steam engine and boilers. The ore is crushed, sized by revolving screens to one-quarter inch size, and then jigged. The coarse is then elevated, reground, and run over Kirk concentrating-tables. It is estimated that not less than 80 per cent of the assay values are saved by this process.

MOFFAT COUNTY

Moffat County occupies the extreme northwest corner of the state and was originally a part of Routt County. It is the least developed of any of the counties, and has no railroad connection except at Craig, near the line between Routt and Moffat Counties. The Denver & Salt Lake Railroad was completed to Craig only recently. The mineral section is in the extreme western part of the county and eighty-five miles from Craig, and can be reached only by wagon-road. It has the largest area of government land of any county in the state and much of it is highly mineralized,

In the Blue Mountain district valuable zinc deposits have been found, and have been opened sufficiently to prove that the ore bodies are large and valuable. There have also been discoveries of carnotite, which show moderate values. About fifty claims have been located by various persons, the most promising of which is the Ross group of seven claims, owned by Ross, Smith & Co. This group has been developed to a depth of twenty feet, and a vein four feet in width has been exposed, carrying gold, silver, copper, and carnotite values.

Extensive copper deposits have been found in the Douglas Mountain district, which is thirty-five miles north of Blue Mountain. The richest mine of this district is the Copper King, a producer of considerable native copper and lower-grade ore. The richest of the ore was at first hauled by wagon a distance of seventy miles to Rock Springs, Wyo., and thence shipped via the Union Pacific Railroad to the nearest smelter for treatment. Later the excessive cost of transportation was eliminated by the erection of a small smelter at the mine. This property was worked through a shaft to a depth of 250 feet, and produced many tons of ore. At this depth, through a fault, the vein was lost, and on account of the excessive flow of water the owners became discouraged and stopped operations.

GRAND COUNTY

Grand County includes a section of the state lying between Boulder and Gilpin Counties on the east and Routt County on the west. At least one-half of its entire area is highly mineralized, but little attention has been given to mining, and its chief industries have been farming and stock-raising. About 100,000 acres, mostly in the mineralized belt, are included in the government forest reserve, which may account for the indifference to metal-mining. Only 100 claims have been located and patented, and, with the exception of two claims, only the necessary work to perfect titles has been done upon any of them. The building of the Moffat Railroad will undoubtedly benefit the undeveloped territory in the vicinity of the railroad, as heretofore all of the prospecting has been done at distances of fifteen to thirty miles from the nearest railroad stations.

The Ready Cash group, that has been a good producer of high-grade silver and lead ores since 1880 is still operating with good profits. This group is situate near the line between Grand and Clear Creek Counties, and the ore is hauled by wagon over Jones Pass to Empire station, and thence via the Colorado & Southern Railroad.

The Mollie Groves group has been systematically developed since 1906, and is a copper proposition carrying some gold and silver values. It is situate on Elk Mountain, in the Blue Ridge district, and is fifteen miles from the town of Parshall, on the Moffat Railroad.

In 1878-79 some very promising silver prospects were discovered in the Rabbit Ear Range, which is about twenty-five miles northwest of Hot Sulphur Springs. Considerable work was done at the time, but all were abandoned on account of the long haul and the low price of silver.

CONCLUSION

Only sixteen written recommendations were found necessary to send to mine managements in the district for violations of the mining law during the biennial period just ending, as compared with forty-five issued by me in 1911-12, and forty-seven in 1909-10. This improvement is largely due to the greater familiarity with the statutes relating to metalliferous mining, which has been sadly lacking in previous years in numerous instances. Also, fewer verbal recommendations and suggestions were found necessary during the same period, and in nearly all instances these were accepted and cheerfully carried out when made. Copies of the mining laws, and the state code of signals, notices, and accident blanks, have been furnished in required numbers to every active mine in the district. The many kind acts and courtesies shown to the inspector by the several managers during the two years have been greatly appreciated by him.

Review of District No. 2

By JAMES T. STEWART, Inspector

TELLER COUNTY

The Cripple Creek Mining District occupies the ground floor of a volcano, the superstructure of which has been removed by erosion. It is situated in a complex volcanic rock, lying upon the south slope of a mass of granite whose culminating point is Pike's Peak.

These volcanic rocks found vent through the underlying granite during an early part of the last of three great geological periods known to scientists as the Miocene.

The granite is a peculiar type, known, by its prevalence in this district, as Pike's Peak granite.

The principal of these volcanic rocks is andesite-breccia, penetrated and traversed by later volcanic rocks, of which phonolite is the most important in its relation to the occurrence of ore. The phonolite occurs for the most part in dikes; that is to say, in vertical sheets which traverse the older formations, the granite and breccia, in various directions, uniting in places in large beds.

Gold, the search for which is the basis of mining activity, occurs either in native state or in the form of a telluride. It is distributed among the interstices of the rock lining the fractures, or penetrating the substance of it in threads and particles of varying minuteness. In the lodes traversing the granite the gold, or the telluride containing it, is found scattered amid the porous cavities due to the removal of certain more soluble portions of the rock. In the phonolite the values are found more frequently in the fractures than in the body of the rock. In the andesite-breccia, the component fragments of which are so heterogeneous, the physical character of the rock varies considerably, and the gold values partake of a more sporadic distribution.

The ore-bearing area has been satisfactorily extended in depth, and the deeper mines find that the ore veins continue in their course and are as rich in depth as they were nearer the surface. The veins are true fissures proven to a depth of 1,850 feet.

The gold-producing area of the camp has yielded a gross bullion value of \$323,653,402.30, of which \$13,302,182.30 was produced during the year 1913.



Pueblo Plant of The American Smelting and Refining Co.

The mills in El Paso County that have been treating Cripple Creek ore report as follows:

The Golden Cycle Mill, located at Colorado City, and using the cyanide process, treated a dry weight of 377,500 tons, with a gross bullion value of \$7,550,000.

The Portland Gold Mining Company's mill, located at Colorado City and using the cyanide process, treated a dry weight of 118,541 tons, with a gross bullion value of \$2,544,526.

The American Smelting and Refining Company, at Denver and Pueblo, treated a dry weight of 36,710 tons, of an average value of \$54.90 and a gross bullion value of \$2,016,324.46.

The local low-grade mills have been operating very successfully and have produced a bullion value of \$1,191,281.84. They report as follows:

The Portland Mill, located on the north slope of Battle Mountain, has a daily capacity of 500 tons. The ore is concentrated and the slimes reconcentrated and treated with cyanide and other chemicals so far secret. During the year 1913, 179,918 tons were treated, with an average value of \$2.79, and a gross bullion production of \$532,866.

The Stratton's Independence Mill, located on the southeast slope of Battle Mountain, has a daily capacity of 300 ton. The ore is concentrated, the sands leached, and the slimes treated with bromo-cyanide. A tonnage of 131,026 was treated, with an average value of \$2.67 and a gross bullion value of \$349,887.54.

The Colburn-Ajax Mill, situated on the southwest slope of Battle Mountain, has a daily capacity of 200 tons. The ore is concentrated and cyanided. They report 52,581 tons treated, with an average value of \$3.08 and a gross bullion production of \$162,260.60.

The Gaylord-Dante Mill, located on the west slope of Bull Hill, using the simple cyanide process—to-wit, crushing to a one-fourth mesh and leaching—has a daily capacity of 75 tons. During 1913 it treated 15,595 tons of ore, with an average value of \$2.77 and a gross bullion production of \$33,597.70.

The Wild Horse Mill, located on the north slope of Bull Hill, has a daily capacity of 75 tons and uses the simple cyanide process. It treated 13,865 tons of ore, with an average value of \$3.38 and a gross bullion production of \$46,910.

The Kavanaugh-Joe Dandy Mill, located on the southeast slope of Raven Hill, has a daily capacity of 100 tons and uses the simple cyanide process. It has treated 19,315 tons, with an average value of \$2.10 and a gross bullion value of \$40,600.

The Isabella Mill, located on the northeast slope of Bull Hill, and having a daily capacity of 100 tons, has been treating the ore by percolation without crushing. It is also retreating the tailings dump. During 1913 a weight of 9,290 tons was treated, with an average value of \$2.13 and a gross bullion production of \$20,760.

The Rex Milling and Mining Company, located on the south slope of Ironclad Hill, has a daily capacity of 125 tons and uses simple cyanidation. During the year 1913, 2,700 tons were treated, with an average value of \$1.68 and a gross bullion production of \$4,400.

The Free Coinage Company has just completed the Neville Mill at Altman, and expects to make good reports for the coming year.

The Blue Flag Mill, situated on the summit of Raven Hill, is a very complete mill of 100 tons' capacity. It has not been operated during 1914, but the company expects to start operation during 1915.

Deep Development

The larger mines are operating at a depth of from 1,000 to 1,850 feet, and find that the veins continue both in size and value as depth is attained.

On Battle Mountain, the Portland, Strong, Granite, and Stratton's Independence are producing steadily an ore of excellent grade.

On Bull Hill, the Vindicator, Golden Cycle, School Section, Free Coinage, Eagles, and Isabella are all producing steadily.

The Vindicator Company sunk to a depth of 1,800 feet, and built a combination dry and wet screening plant during 1914.

On Raven Hill, the Elkton, Cresson, Mary McKinney, Joe Dandy, Blue Flag, Dr. Jack Pot, and others are producing heavily and paying good dividends. A large body of ore was encountered on the fourth level of the Joe Dandy.

On Guyot Hill, the Columbia Mining and Development Company is sinking the Chickenhawk shaft of the Katinka Mining Company, expecting to cut a body of ore coming north from El Paso.

On Beacon Hill, the El Paso, Henry Adney, Gold Dollar, and others are continuing to ship a good grade of ore, adding greatly to the output of the district.

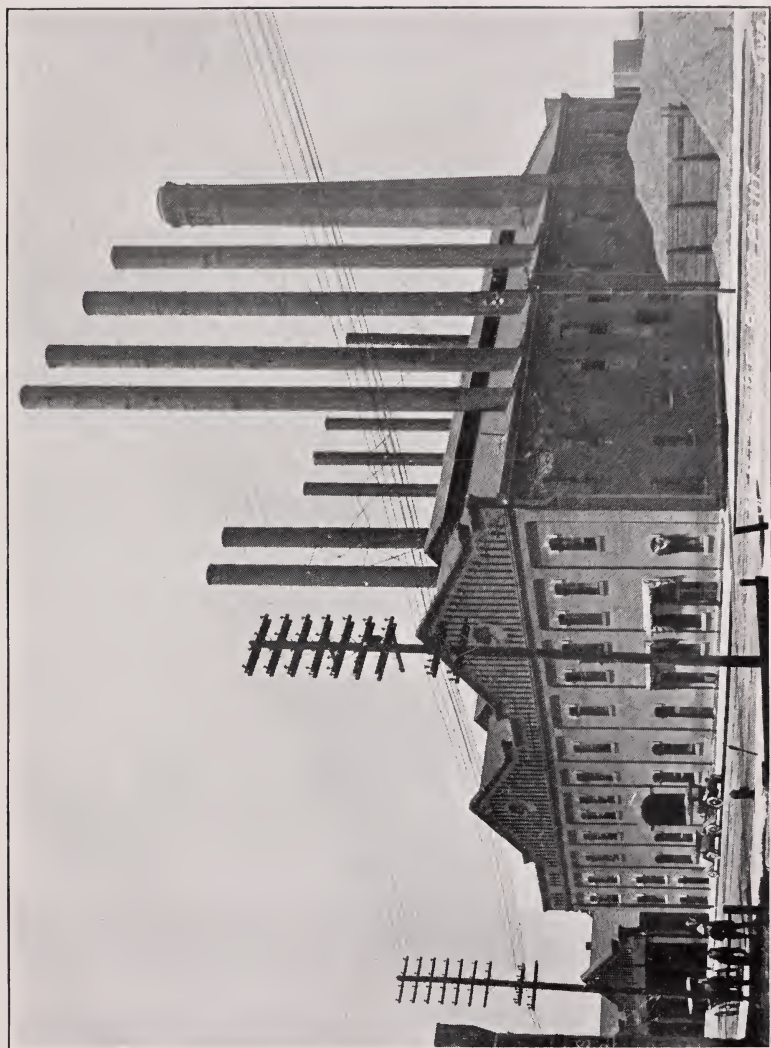
On Gold Hill, the Gold Bond, Anchoria Leland, Midget, Gold King, and Abe Lincoln are being operated largely under lease and are contributing greatly to the output of the district.

On Ironclad Hill, the W. P. H., Jerry Johnson, Forest Queen, and Damon are listed among the heavy producers, and the values are holding out with depth.

On Big Bull Mountain, the Masterpiece Tunnel is in a distance 1,850 feet, and the management has recently let a contract to drive the tunnel 1,250 feet farther.

CONEJOS COUNTY

Platoro, the principal mining camp in Conejos County, is located on the Conejos River, in the southern part of the state.



The Arkansas Valley Railway, Light & Power Co. Power Plant, Pueblo, Colo.

The veins are true fissures, large, and heavily mineralized. They are, as a rule, low-grade. The country rock is andesite and trachyte, and the geological period Tertiary.

The Mammoth and Revenue Mines, which are located in this district, have produced millions. The Glacier, the Valley Queen, the Merrimac, the Century group, No. 10 Mine, the Euridice, the Forest Queen, and the Victoria are all very promising mines and are showing some high-grade values. Little work is being done because of the high cost of transportation. The Singleton-Sunbeam Mining Company has opened up an excellent vein of ore at a depth of 50 feet.

RIO GRANDE COUNTY

Summitville, the principal mining camp of this county, is located in the Rio Grande Mountains. There is no good geological survey of this district. The country rock is rhyolite and andesite, and the geological period is Tertiary. The veins are true fissures, and the gangue principally porphyry and trachyte. Little is being done here at the present time because of the high cost of transportation.

CUSTER COUNTY

The Hardscrabble Mining District is in a locality of which the country rock is granite and diorite, and the vein-filling tale, quartz, and porphyry.

The Silver Cliff Mining and Milling Company, the old Geyser shaft of which is the deepest in this district, has reached a depth of 2,600 feet. It is not operated at present, but it is expected to resume early in the spring. The main vein was not encountered after a depth of 1,800 feet. The intention at the present time is to cross-cut to this vein.

The famous old Bassick Mine is operated under lease and is producing steadily. A fifty-ton cyanide plant is handling the low-grade ore from the mine and retreating the tailings dump at the old mill.

The Bull Domingo is operated under lease and producing a good grade of ore.

The Jocomo Mine, operated by the Styner Brothers, has been developed by two shafts and a tunnel 1,200 feet long. They have opened up a strong vein carrying gold and copper. Prospects are good for heavy shipments in the spring.

The Wisconsin group is producing a good grade of smelting ore, and a small cyanide mill is treating the low-grade ore from the mine.

The Captain group, near Rosita, is managed by John Edmunds, of Westcliffe. Good, substantial development work is being done.

The Creede and Cripple Creek, the Virginia Mining Company, the Humboldt Mining Company, the Pocahontas Mining

Company, the Midnight Mining Company, and the Mary K. Mining Company, near Rosita, have excellent showings, but little work is being done on account of the high cost of transportation.

FREMONT COUNTY

The principal mining camp, Cotopaxi, is located in a district in which the country rock is granite and the vein-filling principally quartz and porphyry. The metal is copper. Many good prospects are opened up, but little work is being done.

Mining for gems and precious stones is carried on profitably in this county by Endicott and Davis.

EL PASO COUNTY

The large reduction plants that have been treating the Cripple Creek ores—to-wit, Golden Cycle Mill, Portland Mill, and United States Refining and Reduction Company—are located at Colorado City. With the exception of some prospecting, there is no mining being carried on in this county.

There is no metalliferous mining in Pueblo, Las Animas, and Huerfano Counties.



Canon City Power Plant, Canon City, Colo. The Arkansas Valley Railway, Light & Power Co.

Review of District No. 3

By JOHN R. CURLEY, Inspector

EAGLE COUNTY

The Battle Mountain district shows an improvement in mining operations in 1914. The Eagle Mining and Milling Company's group of mines, consisting of the Iron Mask and its adjoining claims, are still the leading producers of the district, both in tonnage and values.

The most noted addition to the list of producing mines on Battle Mountain is the property of the Eagle Bird Tunnel and Mining Company, consisting of the Black Iron, Ground Hog, and Champion claims. These are now being operated by the American Zinc Company, which has retimbered the incline and underground workings of the Black Iron, and placed a substantial plant of machinery on the property. The company has commenced shipping zinc ores.

The Success Mining and Leasing Company, a local corporation, working the Bleak House and other properties on Battle Mountain, met with a severe reverse in the spring of 1914, when fire destroyed the surface plant on the Bleak House property. This retarded shipments of ore during the past summer.

The Eagle-Fulford district, which two years ago gave much promise of being one of the great mining camps of the state, has not developed so far into what might be called a permanent mining district. The mines on Horse Mountain, eight miles from the town of Eagle, during the year 1913 and the early part of 1914 produced a large quantity of high-grade silver-bearing ores from the sandstone formations that are exposed in that locality. The Lady Belle Mine, the principal producer on Horse Mountain, in 1913 shipped to the smelters a large tonnage from the workings near the surface on the outcrop of the vein—or deposit, as it might be properly termed. A shaft was sunk from the floor of the tunnel, about 150 feet from the portal, on the vein, but as depth was obtained the value of the ore decreased, until the product became too low to pay for mining, treatment, and transportation charges. The mine was closed down in the spring of 1914.

In the camp of Fulford a number of prospectors have been working during the past year, and although a number of discoveries of mineral of a good grade have been reported, no shipments of ore have been made.

In the Holy Cross district no work has been done for the past few years, and it is more than probable that the district will remain idle until suitable wagon roads are constructed.

The Wyoming Mine, within a few hundred feet of the town of Red Cliff, after lying idle for many years, has recently been reopened by local lessees, who are shipping to the smelters every week about two cars of a fluxing lime, carrying from fifteen to twenty ounces of silver. The product is a dolomite limestone, impregnated with chloride of silver, and is in considerable demand by the smelters for fluxing.

CHAFFEE COUNTY

In the Cottonwood district the great producing mine is that of the Mary Murphy Gold Mining Company, which is working the largest force of men in its history. The mine with present equipment, both underground and on surface, is capable of producing an immense tonnage of ore, both in crude mineral and in concentrates from its mill, having a capacity of 250 tons a day. The most important feature of this mine at present is the "Golf Tunnel," which has been driven into the mountain as an adit for a distance of 3,800 feet, where it intersects the vein, and is then continued on the course of the vein 2,000 feet, making the total length of the bore from the portal 5,800 feet. A short distance from the terminal a three-compartment upraise is being worked, which, when finished, will connect the tunnel with the present workings of the mine, which are 900 feet above the tunnel level. The completion of this work will give a direct outlet of the product from the mine to the mill, which is situated at the portal of the tunnel.

The Flora Belle Mining Company, a mile above Romley, has been working a few men during 1914, and although no shipments of ore have been made during 1914, a vein of mineral has been opened that gives promise of good results and will probably place the property on a shipping basis before long.

A short distance above the town of St. Elmo, the Gold Queen Mining Company has been driving a tunnel in the mountain, which has reached 800 feet. Several stringers of mineral have been cut in the last 100 feet of driving, and the indications are that the main body of ore will be reached in the next 50 or 100 feet.

In the Monarch district, the Madonna Mine, now operated by the Monarch-Madonna Leasing Company, has shipped to the smelters considerable ore, running high in gold, silver, and lead, during 1914. This great mine, which up to the year 1893 produced \$4,500,000 worth of ore, had remained idle since that time until the present leasing company took hold of the property and drove a new tunnel, known as Tunnel No. 6, a distance of 1,500 feet. The tunnel follows the granite limestone contact, where an ore shoot was encountered, that has since produced large quantities of gold-, silver-, and lead-bearing min-



Ohio-Colorado Smelting and Refining Co.'s Plant at Salida, Colo.

eral. Twelve hundred feet from the portal of the tunnel an interior shaft has been sunk on the ore body, to a depth of 250 feet. The average value of the ore at this point shows an increase over that produced above the tunnel level. The shaft also demonstrates the fact that the ore shoot is persistent in depth.

In the Garfield district, the Jewell Tunnel and Mining Company has steadily worked a small force of men during the years 1913-14, and produced a few shipments of fair-grade ore. A considerable amount of development work has been done on this property during the present year.

The Taylor Mountain Mining Company—better known as the Lilly Mine—was closed down for a short period during the past summer, but resumed recently with a considerable force of men. The property is worked by a tunnel about 2,600 feet in length. About 2,000 feet from the portal an interior shaft has been sunk. The mine is well equipped for future operations on a large scale, having an aerial tramway to deliver the ore to the tracks of the Denver & Rio Grande Railroad at Garfield, compressor to run the machine drills, electric hoist on the shaft, electric fan for ventilation, and all the modern improvements to conduct mining operations on an economical basis.

The Hawkeye Mine, lying southwest of and adjoining the Madonna property, is again working after a period of idleness. The property is operated by lessees, who commenced work in June, 1914. The property is opened by a tunnel 550 feet in length, driven through the granite, to the granite limestone contact, and thence along the contact, 300 feet. The mine is equipped with an electric hoist for sinking, as it is the intention of the lessees to sink on the vein below the tunnel level, because the ore bodies above the tunnel are practically exhausted.

The quarries at Garfield give employment to a large number of men, producing a limestone flux, which is used by the Ohio and Colorado Smelting Company's plant at Salida.

The Sedalia Copper Company's Mine, in the Cleora district, four miles north of Salida, shipped to the smelters several lots of copper-bearing ores early in the spring of 1913. The mine was closed down in the fall of the same year, and has not resumed operations since that time.

SUMMIT COUNTY

In the Breckenridge district, mining has been fairly active during the years 1913-14. The Wellington Mines Company, early in the present year, did not work the wet concentration mill, which reduced shipments of ore to a considerable extent. Treatment was confined solely to tailings that came from the wet mill, which were run through the roasting-mill and made a commercial product by desulphurizing. The company has recently started up the wet concentration mill, and heavy shipments of concentrates are now being made. While this mill was idle the force in the

mine was reduced, and no attempt made to break ore, except where it had to be removed in the work of development for future operations. The result was that large stocks of crude ore accumulated, which will keep the mills going for some time without drawing upon the reserve ore bodies that are blocked out in the mine.

The Dunkin Mining Company, which is worked by lessees, has been very successful during the past year in opening up bodies of high-grade gold ores. In many instances this metal has been found in the vein in a pure state, and a considerable quantity has been sent to the United States Mint in Denver in metallic form as it came from the mine. Large bodies of low-grade ore have also been opened, and the lessees are contemplating erecting a concentrating mill.

The lessees on the Gold Dust-Ouray-Puzzle combination have recently begun shipping a good grade of ore to the smelters, and have considerable reserve ore bodies in sight, which will insure steady shipments for some time. This property has been idle for several years, owing to litigation. Leadville and Breckenridge men succeeded recently in bringing the conflicting interests together and furnished capital for a long-time lease on all the properties.

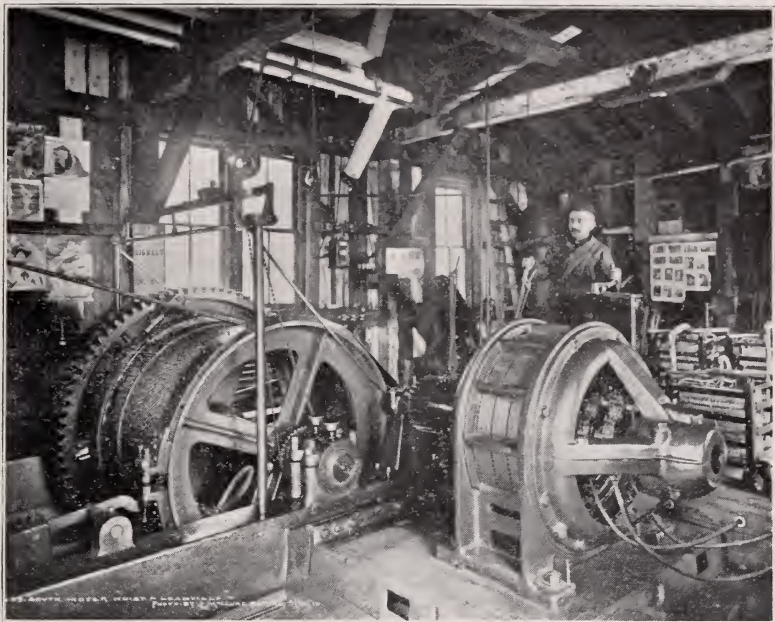
In the Kokomo-Robinson district, mining seems to be practically at a standstill, with the exception of a few men working for the John B. Jr. Mining Company in Mayflower Gulch. No ore is being shipped from this locality. The closing-down of the King Solomon-Robinson Company's mine and mill, which formerly worked from fifty to sixty men, has had a depressing effect on all other mines in the camp.

The Blue Flag Mining Company, at the head of Illinois Gulch, has been operating during the past year. Recently the company's mill has been closed down for re-modeling, for the purpose of making a closer saving of the values.

At the head of the Blue River, the American Mining Company is working a few men on the Eldorado claim. The Big Reserve Mining Company which last year worked the Monte Christo property, has closed down both mine and mill.

In the Montezuma district, the St. Johns Mine is working a considerable force of miners and sending to the smelters a good grade of ore. Early in the spring of this year the company closed down its concentrating mill, and is now shipping only the crude ore taken from the mine. The presence of barium, accompanying the lead ores of this property, makes it a very difficult matter to obtain a satisfactory separation by wet concentration, and until some process is devised to handle the lead product at a profit, it is doubtful if the present mill will again be put into commission.

The Bolivar Mining Company has built a new concentrating mill this year, and a trial run on dump ore that was broken in the mine some years ago was very satisfactory, giving a concen-



Electric Hoist (112 H.P.), South Moyer Shaft of Iron Silver Mining Co.,
Leadville, Colo. Served by The Colorado Power Co.



Emergency Steam Plant of The Colorado Power Co. at Leadville; 100,000-Volt
Transformer Station in Background.

trate of 52 per cent zinc and 10 per cent lead, with small values in silver. The mill is equipped with five Wilfley tables, and more will be added as circumstances require.

The Bessie Cora and Chataqua Mining Companies are also working small numbers of men in this section, and shipping occasional lots of ore.

The closing-down of the mine and mill of the New Pennsylvania Mining Company in 1913 practically cut off all shipments of ore from the Argentine district for the present year. A small force of men has been employed at the Shoe Basin Mining Company's tunnel, at the head of Peru Creek, mostly in development work. No ore was shipped in 1914.

The Philadelphia Mining Company has recently commenced putting its mine in shape for future operations. A consolidation of interests was effected with the Colorado-Toledo Mining Company, on the opposite side of the mountain, and the tunnels of both companies are to connect the levels of both workings. They are practically the same in elevation, and the product of both mines will be treated at the Colorado-Toledo Company's mill.

Dredging in Summit County

Dredging the river beds for gold is one of the great mining industries of Summit County. The French Gulch Dredging Company (known as the Reiling dredge) last year removed its machine from its old position to a site farther up-stream, above the Wellington Mine, and is now engaged in tearing up a valuable section of placer ground. It is producing and sending to the Denver Mint bars of gold valued at from \$8,000 to \$10,000 every week.

The Tonopah Dredging Company, working one dredge at the mouth of French Gulch and two on the Swan River, produces about the same amount of value weekly to each dredge employed. This company has purchased the works of the old Gold Pan Company, and has a complete set of machinery for repairs, and work necessary to keep the dredges in operation.

While the shutting-down of two large enterprises like the New Pennsylvania Company and the King Solomon Mining Company's mines and mills has decreased the number of men employed in Summit County by about one hundred, new mines are already taking their place, and the quota will be filled before the close of 1914.

LAKE COUNTY

Notwithstanding the reduced quotations in spelter, compared with the price obtained in the years 1912-13, which has caused the stoppage of numerous small properties that could not ship carbonate of zinc below 25 per cent at the ruling prices of 1914, the Leadville district, according to the reports received from the

smelters of Leadville and Salida, is now handling a greater quantity of ore than has been produced from the local mines for a number of years.

This may be accounted for by the number of new properties west of the Arkansas River, that developed into shippers of considerable magnitude during the years 1913-14. The Lackawanna Belle Gold Mining Company on Sunset Mountain, is producing three to four cars of ore a month that averages from seven to eight ounces in gold per ton, with a small percentage of silver. Eastern capital has been attracted to this section, and arrangements have already been made to drive a tunnel at a greater depth, to intersect the vein and handle the product in a more economical manner. With these improvements, it can be confidently asserted that the Lackawanna Belle will take its place as one of the heaviest producers, both as to tonnage and values, in the new district.

The Mount Champion Mining Company, in the Half Moon district, is shipping only its high-grade ores, the low-grade ores being blocked out, awaiting the construction of a mill of greater capacity, and of more modern methods, than the one now in use.

The Dinero Mining and Tunnel Company, on Sugar Loaf Mountain, has been a steady producer of high-grade silver ores, that carry also a few dollars in gold to the ton. An interior shaft has recently been sunk 200 feet below the tunnel level, which shows the vein to be stronger than that exposed in the upper workings and of greater value in silver and gold contents.

The Consolidated Virginus Mining Company, an adjoining property, has recently been placed on the shipping list, with very good prospects of maintaining a steady production for a considerable period.

The Fidelity Mining, Milling and Power Company, on the north fork of Lake Creek, recently opened a large vein of mineral in a tunnel driven 1,200 feet into the mountain, and the indications are that, as soon as roads can be built and a method of transportation secured, a considerable output of ore will be shipped.

Of the older mines in the Leadville district proper the output of ore has in no manner been decreased by the reduced market prices on silver, lead, and spelter. On Carbonate Hill, whence comes the great volume of carbonate of zinc ores, the same steady production is maintained by the Western Mining Company and the Star Consolidated Mining Company. These two properties produce 50 per cent of the zinc-carbonate ores mined in Colorado.

Iron Hill, where are situated the Iron-Silver Mining Company, the Yak Tunnel and Mining Company, the Lonisville Mine, and the Empire Zinc Company (Colonel Seller's mine), is maintaining the same steady output of zinc sulphides that gives the Leadville district its enormous production.

On Breece Hill, the Ibex Mining Company (Little Jonny Mine), the New Monarch Mining Company, the Ethelma Mining Company, and the Luema Mining Company, on what is known as the Leadville Gold Belt, are large producers of gold-copper ores. These properties are now being worked by lessees, on what is known as the block system, the usual method being to subdivide the properties into areas of a certain number of feet, which are worked by parties of miners, numbering from two to fifteen, who share equally in the proceeds of the venture. The companies, as a rule, retain control of the management of the mine and machinery. The company's foremen, engineers, and timbermen keep the mine in proper condition for legitimate mining.

Since the discovery of the argentiferous lead ores in 1877-78, almost all of the vast wealth produced in the Leadville district has been taken from the eruptive and sedimentary formations. Very little attention has been paid to the lower granitic rocks, with the exception of the Cleveland fault fissure, that courses in a northerly and southerly direction through Breece and Little Ella Hills, and the country lying west of the Arkansas River.

Bald Mountain Active

On Bald Mountain, at an elevation of 11,800 feet, the granite formation is exposed by erosion, and numerous outcroppings of vein matter can be seen, accompanying the porphyry dykes that abound in that locality. The action of the elements has to a great extent leached the values. In September, 1913, a company of capitalists from Bisbee, Ariz., formed what is known as the Mosquito Range Mining Company, secured by purchase a considerable tract of territory covering these outcroppings, and proceeded to drive a tunnel, the object being to cut these dykes at right angles at greater depth, and ascertain if they contained ore bodies of commercial value. This company recently purchased and set in place a complete plant of the latest improved machinery, consisting of an air compressor, power drills, and the necessary equipment to drive the tunnel a sufficient distance to demonstrate the value of the property. The power will be furnished by the Colorado Power Company, which has recently extended its line to this section. This bore has already been driven a distance of 500 feet into the mountain by hand drilling. It is estimated that, by the use of power drills, 250 feet per month can be made, thus solving the question as to the continuation in depth of the veins exposed on the surface.

An enterprise that is anxiously awaited by the mining men of Lake County is the unwatering of what is known as the Down Town District, that will bring once more into commission such properties as the Penrose, Bon Air, Coronado, Grey Eagle, Pocahontas, Weldon, Bohn Shaft, Sixth Street Shaft, and many other small mines that ten years ago produced a great proportion of Leadville's tonnage. The unwatering of these mines, and active

mining operations resumed, would undoubtedly mean the employment of 600 more men added to those now working, and an increase of 20,000 tons per month to the present tonnage.

When mining was suspended in the properties above mentioned, nothing was known of zinc carbonates, and there is no manner of doubt but that when the Penrose Shaft is unwatered to the 850-foot level the same great zinc-carbonate shoot will be found extending westward below the Carbonate fault as was found above in the Maid of Erin, Brooklyn, Clontarf, Adams, and other properties worked by the Western Mining Company and the Star Consolidated Mining Company's group of mines. It is well known that the first carload of zinc carbonates shipped out of the Leadville district was picked out of the Penrose dump. While many of our mining men have been disappointed that work on these mines has not been resumed at an earlier date, it must be recollected that those who are financing this enterprise have had a great deal to contend with. The owners of the properties are virtually scattered over the four corners of the earth, and to get the signatures of all for one organization has been a work of magnitude.

New Zinc Smelter Operating

The new plant of the Western Zinc Milling and Reduction Company, which commenced work on the reduction of low-grade carbonate-of-zinc ores to produce a zinc oxide, has been conducted successfully for the past two months. This smelter was erected for the purpose of treating zinc ores of from 15 to 18 per cent, that would not bear shipment to the Oklahoma and Kansas smelters, thereby saving the freight rates to these points. At present the capacity of the works is one unit, or fifty tons of ore per day. It is the intention of the management, when the success of the process is fully demonstrated, to increase the plant to three more units, with a capacity of 200 tons per day. When this is accomplished it will mean a great deal to the mining industry of Lake County—not so much in the number of men employed, nor yet in the tonnage that the smelter will consume, but in disposing of a large quantity of material that would otherwise go over the dumps as waste. It will aid in the development of the various mines that produce these ores, and probably lead to the discovery of richer ore bodies that would otherwise remain hidden.

The mining and smelting industries of Lake County are in a prosperous condition. The fact that 750 men now find employment at the local smelter, as against 625 in 1911-12, shows that the tonnage produced in the district has not decreased. Mining in Leadville and its tributary camps is done on a legitimate basis; no advertising is resorted to for the sale of stock, and the mining companies that are organized are formed into corporations, more for a division of interests than for stock sales. There are no press reports regarding dividends, as each company may

be regarded as a close corporation, whose business is transacted solely in the interest of the stockholders themselves. So-called "booms" are not encouraged in the Leadville district, and many important discoveries of mineral are often made that, but for the reports of the United States Geological Survey and the State Bureau of Mines, would never be heard of outside of the district.

Empire Gulch Section

Lying to the southeast of Leadville, in what is known as the Empire Gulch section, is a large area of exposed blue limestone, denuded of its porphyry covering by erosion. The scored surface of the rocks shows the movement very plainly. This belt of limestone is covered with a network of crevices, dipping vertically (one can hardly call them veins), that are filled with mineral matter—whether by infiltration or injection, geologists must decide. Whatever may be the theory of deposition, the fact remains that values are there.

If these crevices contain mineral in paying quantities, is it not reasonable to suppose that they continue downward to at least the depth of the blue limestone formation which in this vicinity is about 200 feet in thickness?

If caused by infiltration, it is probable that a resting-place was found for the ore bodies on the contact between the blue limestone and the upper quartzites; or, if the theory of injection holds good, then the main ore channels must be below the parting quartzite and the white limestone formation.

From these crevices there have been shipped to the local smelter, as the returns show, over 500 tons of ore, of an average value of \$25 per ton, in silver and lead. There is no doubt that, as depth is attained, and the mineral protected from the leaching process (the deepest workings are only sixty feet), the values will materially increase.

There should be encouragement enough in these figures—which are reliable and not guesswork, as they are taken from the returns of the American Smelting Company—to cause an effort to be made to develop this section, which practically lies at the doorstep of the city.

The deep erosion caused by the glacial action that formed Empire and Iowa Gulches precludes the chance of an expensive water cost in deep mining, and a shaft would probably reach the depth of the granite formation before water in any considerable quantities would be encountered. This makes it an ideal district for economical mining, and no other locality in the country offers better inducements for individuals or companies of limited capital to secure a return for their investments.

No other mining field can compare with Colorado, and particularly Leadville, in this regard. In the copper fields of Butte, Mont., and in the State of Arizona, there is no place for the small operator. No copper property can become successful with-

out owning its own smelter, as the smelters owned by the large companies can scarcely keep up with their own production. The outlay of capital that is required to place a copper property on a paying basis, even after a pay vein has been found, is enormous. As a result, the average miner in those localities either works for wages for one of the large companies or is idle. In Leadville the miner, when he accumulates sufficient funds to take a chance on a lease, or on a piece of ground that he looks upon as a favorable investment, invariably does so, hoping that fortune may favor him in securing a competency. He is aware that he can dispose of his product immediately, and turn the same into cash at the local smelter.

PITKIN COUNTY

The Smuggler Mining and Leasing Company made an increase both in the number of men employed and in the tonnage sent to the smelters from both mine and mill in the last two years. It is probable that a further increase will be made in 1915, as from the large acreage held by this company, the large reserves of mineral blocked out, and the modern improvements installed underground to facilitate the handling of the immense quantities of material required to work a mine of the magnitude of the underground workings of this property, it can reasonably be expected that the year 1915 will show a larger production and increased earnings. This enterprise is the mainstay of the town of Aspen.

On Aspen Mountain, such old-time properties as the Aspen, Durant, and Spar Consolidated Mining Companies are still giving employment to a number of men and producing a considerable tonnage of argentiferous limonitic ores, that are in demand at the smelters for fluxing material.

Early in 1913 a number of the citizens of Aspen formed a mining corporation, known as the Hope Mining, Milling and Leasing Company, for the purpose of unwatering and working the Little Annie group of mines on Richmond Hill, together with other properties in the vicinity. They also secured a ten-year option on the Famous Tunnel, which in early days had been driven 1,000 feet in the direction of the Little Annie group. This tunnel has been extended over 3,000 feet since the present company commenced work, making the total distance 4,000 feet. Measurements made by competent engineers give the distance yet to be driven approximately 500 feet. When this point is reached, it is confidently expected that shipments of ore will commence.

On Castle Creek, a few miles above the town of Aspen, a local syndicate, known as the Contact Mining Company, has driven a tunnel into the mountain several hundred feet, as a prospecting enterprise, to cut the veins that are shown in the outcroppings on the side of the mountain.

PARK COUNTY

Lode mining in Park County has not improved materially during the years 1913-14. The most noted change is the resumption of operations by the London Mining and Reduction Company. The leases on the property have been canceled, and a force of twenty-one men has been placed at work retimbering the old workings, and making preparations to sink a shaft near the portal of the South London Tunnel, to cut the great fault plane at a lower depth. The ore bodies above the level of the tunnels being practically exhausted, it became necessary to sink a shaft and drive levels below the ore bodies that were stoped out in the upper workings, or go farther down Mosquito Gulch and bring in a lower tunnel that would cut the vein at greater depth. As this would necessitate driving a tunnel about a mile in length to get 500 feet below the old workings, the management concluded to adopt the shaft plan as more economical and speedier. When these plans have been perfected and the mine once more placed on the shipping list, it will undoubtedly cause a great revival of mining in Park County, as the London Mine is known to be one of the greatest mines in Colorado. It will probably average more in values for the tonnage shipped than any other mine in Colorado. Previous to the abandonment of work by the company in 1912, the last 1,700 tons of ore shipped to the smelters averaged, in gold, 2.66 ounces; silver, 2.4 ounces; lead, 3.1 per cent.

The Chance-Hilltop Mine, at the head of Horseshoe Gulch, is about the only other mine in Park County working any considerable force of men. Ore cannot be shipped from this property during the winter months, by reason of the branch line of the Colorado & Southern Railroad suspending traffic to Levick on account of the deep snows prevalent in that section. The mine accumulated considerable ore in stock, which has been moved to the smelter during the summer months. The flooding of the lower levels of the mine by the spring thaws has retarded operations to some extent, but this is only a temporary setback, to be expected every spring on account of the heavy snowfall during the winter.

Above the old town of Montgomery, at the base of Mount Lincoln, a number of prospectors were at work during the summer of 1914, and some very good showing of mineral made, which may eventually develop paying properties.

There have also been some good discoveries of mineral in the Tarryall district. The Oregon group has in stock, ready for shipment, a large amount of lead-silver ores.

The placer-mining properties are reported to have had a very successful season. The heavy snows of the winter of 1913-14 gave an abundance of water for hydraulic mining, which was utilized to the utmost by both the Tarryall and Snow Storm placers.

Review of District No. 4

By SAMUEL TREAIS, Inspector

SAGUACHE COUNTY

Saguache, the county seat, had gained considerable prominence as a distributing point in 1867-68, but the mining history practically begins with 1879-80, during the great rush to the Gunnison country. Many were attracted by the large silver-lead fissure veins on Kirber Creek, and developments seemed to justify the building of the town of Bonanza, which had grown to a place of considerable importance before the fall of 1880. On the west slope of the Cochetopa Mountains the narrow veins of quartz carrying free gold likewise established the camp of Willard, on Cochetopa Creek, a tributary to the Gunnison River.

From these two places prospectors located claims in various parts of the county, attention being about equally divided. During 1881-82 the development and production indicated a new and valuable region. In 1882-83 a number of local reduction plants and mills, unsuited to the somewhat refractory and low-grade ores, were erected. Their failure to overcome the obstacles that led to their construction marked the beginning of a decline, from which the county has not yet fully recovered.

The most prominent mining section in Saguache County is known as Kerber Creek mining district. This mining district is in the north end of the county, near the town of Bonanza, sixteen miles from Villa Grove, which is the nearest point to the railroad. The only mines shipping ore in paying quantities from this district during the past year have been the Bonanza, Antora, St. Louis, Exchequer, and Josephine. The values from those mines are principally lead and silver.

MINERAL COUNTY

Mineral County is almost wholly a mountainous section, and the topography is extremely rugged. On the north the La Garita and Cochetopa Hills form the Continental Divide and contain peaks ranging in altitude from 11,000 to 14,000 feet. The Continental Divide passes on through Hinsdale to the east border of San Juan County in a general west-southwest course, turns abruptly, and follows a general east-southeast course back through the southern part of Mineral County, the summit ranging from 11,000 to 13,000 feet. This portion of the Continental Divide is known as the San Juan Mountains. The region lying between

the mountain ranges on the north and south, or within the big bend of the Continental Divide, is made up of small parks and plateaus, ranging in altitude from 9,000 to 11,000 feet, and each practically surrounded by ridges rising into mountain peaks. The whole is drained by the Rio Grande River and numerous tributaries. A large number of streams occupy deep cuts and almost entirely inaccessible channels, or narrow canons, which, with rugged surroundings, produce in many places a scenic effect that beggars description.

The geological structure of the county is almost entirely of the eruptive lavas common to the San Juan country, generalized as trachytic porphyries. Three successive lava flows, lying conformably one on the other, and differing more or less in composition, are well shown by the various cliff exposures of this region along the Rio Grande River. Between Wagon Wheel Gap and Jintown, and nearer the latter, a small area of nearly horizontal stratified rocks is exposed, by erosion, at different points. This is mainly the Lower Carboniferous, or, as better known, the "Leadville blue limestone." These beds, as exposed on Willow Creek, near Jintown, are cut with numerous vertical eruptive dykes and show a high state of mineralization.

The main ore deposits of the county occur in strong fissure veins. While the fissures have no apparent system and appear to traverse the mountains at all points of the compass, the best developed have a general north-and-south direction, varying in most cases to a northwest strike, with a variable dip to the southwest. A very noticeable feature about the mines in this section is the small amount of waste or dump material present. This fact demonstrates that nearly all material broken in the mines was hoisted to the surface and marketed.

No new strikes of any importance were made in this county during the last two years. The Commodore Mine is being operated under lease. They are shipping from four to five hundred tons of silver and lead ore per month. The Amethyst Mining Company is mining and milling about fifty tons per day; the Creede Mining Company is mining and milling about seventy-five tons per day.

CONEJOS COUNTY

What is now known as Conejos County was originally organized under the name of Guadalupe, in honor of the patron saint of Mexico. As originally constituted, it embraced nearly all the territory in the southern portion of the state. It was one of the original seventeen counties organized by an act of the territorial legislature in November, 1861. On account of confusion liable to arise, the name of Guadalupe was changed to Conejos. The history of the hardships of the pioneers of this section is filled with thrilling episodes, the settlement of the whites being bitterly resented by the Indians. After a considerable season of doubt as to who should gain supremacy, the Indians were compelled to

fall back before the advance of civilization. With later development the princely domain of Conejos County has been reduced to an area of 1,200 miles, with the seat of government at Conejos.

Why mining does not rank as the leading industry in this county is because of lack of development and not because of lack of mineral deposition. The western portion of the county is strictly a mineral section, from Platoro in the north to the banded peaks and Antonita districts in the south. While prospected to a limited extent, it can be properly classed as one of the undeveloped reserves of the state, well worthy of careful investigation.

More or less prospecting was done in this county in 1912-13. A great deal of low- and medium-grade gold and silver ores were opened up in different properties. This district needs mills to treat the ores on the ground.

Some of the old producing mines of this county shipped an enormous amount of high-grade gold ores to the smelter for treatment. There are several properties in this district that could be made to pay handsome profits, if they had milling facilities erected for treating their low and medium-grade ores.

GUNNISON COUNTY

The early history of this section is replete with thrilling episodes. Captain Gunnison, for whom the county was named, met his death at the hands of the Indians in the fall of 1853, while in charge of a United States engineering corps surveying a favorable route across the mountains to the Far West.

In 1861 gold was discovered on Taylor River, in what has since been known as the Tin Cup district—the name arising from the character of utensil used to determine the presence of gold. Almost simultaneous with this was the discovery of gold in Washington Gulch, in the northern part of the county.

In Washington Gulch the gold found was "coarse" and yielded large returns. The amount removed must have been considerable, but the value is unattainable. One of the pioneers of this gulch says: "As long as it lasted it was the richest in the territory. Five to ten ounces was an average day's work, but I had one pan of dirt that gave me \$78 in gold. Twenty-five to \$50 to a pan was not at all uncommon."

From 1861 to 1879 various parties entered this county, with variable success. During 1879 the reports from prospectors established a belief that the Gunnison country was not only more prolific in mineral wealth than Leadville, but that ore bodies of fabulous richness outcropped so as to require no capital for mining, and that ores could be removed and values realized *ad libitum*. As a result, the "rush" of 1880-81 to this section was second to none in the state's history. Towns sprang up in all districts of the county; the mountains were filled with prospectors, who, through specimen assays, kept the excitement at high pitch; the "boom" was launched and maintained; capital

followed and sought investment on the "boom" basis, and smelters and mills were erected at enormous outlay. It was finally realized that the ores, while abundant, were in the main low-grade, and that, under economic conditions then extant, profits from investments made could not be expected. The exodus during the next few years was almost equal to the rush of 1880. No county in the state, as prolific in natural resources, has suffered from a "boom" so severely as Gunnison. This section, however, did not prove an exception to "mining boom" history, and many good pay mines were discovered and opened. These in a measure served to relieve the general depression, and each year from 1885 to 1892 showed gradually increased activity in all the districts. Until this time the production of lead-silver ores received almost undivided attention. With the then current price for these metals, profitable mining was impossible except in isolated cases. Prospecting ceased, and small producers closed. As in other counties, attention was turned to prospecting for gold. While the existence of gold was well known, it had, prior to this time, received little attention. The results have been satisfactory.

During the past year there has been a great deal of prospecting done in the Tin Cup and other districts in the county. The Carter Tunnel and Mining Company is milling seventy-five tons per day in the Gold Brick mining district. During the past few months there has been a great deal of activity in the Vulcan mining district. Considerable ore was shipped from the different properties in the White Pine district. Several properties were opened up during the past year in the Glacier mining district, located about twenty-five miles north of the town of Gunnison. A great deal of prospecting has been done around Pitkin and Bowerman. During the later part of 1914 a dredging machine was placed in operation in the Taylor Park district. I look for the year of 1915 to be one of the most productive years that Gunnison County has ever enjoyed.

SAN JUAN COUNTY

The mines of the various districts of this county are, owing to topography, mainly opened through tunnels, and require no expensive hoisting and pumping plants, but, as a rule, must be equipped with trams to transport to mills at lower altitudes. In ore-dressing the mine operators are not only up to the general standard, but in many respects excel. Concentration has been systematically pursued for a number of years, free from prejudice against, or partiality for, any particular method, process, or mechanical appliance. The results attained are from an honest endeavor to secure the best methods. Under this system, ores of a grade even lower than worked in more favored sections, with short hauls and low transportation charges, are made "to pay." The application of electricity has reached a high state of perfection in this county. The power is generated on the Animas River below Silverton and transmitted to the mines, where it is utilized

for operating mills, compressors, lighting, etc. The mine equipments are thoroughly modern, and in some particulars excel those of other sections.

The general character of the rock met with is eruptive; viz., trachyte, andesite, granites, schists, and gneiss. Metamorphic rocks also occur, tilted at a high angle. The larger part of this area is prolific in strong, well-defined fissure veins, which have been proven to extend to an unknown depth. Many of these veins, notably in the vicinity of Animas Forks and Eureka, are of great width, from ten to 100 feet, and show large bodies of low-grade ores. Lead, zinc, and copper ores in the South Mineral, Ice Lake, Sultan Mountain, Bear Creek, Arasta Basin, Cunningham, Minnie and Maggie Gulches, Boulder Mountain, and Gladstone district, all show well-defined fissures. The veins are as strong and persistent as they are in the Animas Forks and Eureka districts. Most of these veins carry high- and medium-grade gold, silver, lead, zinc, and some little copper values.

The Sunnyside Mines have increased their production during the past two years. They have added twenty more stamps and built a zinc separator at their reduction works. The Silver Lake, the Iowa Tiger, and Gold King Mines are all being operated under lease by Slattery & Mears. They give employment to hundreds of men in that district. There are several mines in the different districts in San Juan County operated by lease. When consideration is taken of the prices of metals for the last two years, San Juan has kept pace with other mining counties in the state.

The Silver Lake mill began in 1914 to treat custom ores, which should be the means of largely increasing the output of low-grade properties.

OURAY COUNTY

The leading mining districts of Ouray County are in the southern portion, embracing part of the Uncompahgre Mountains, recognized as one of the most rugged mountain chains in the state. The drainage is through the Uncompahgre River and its tributaries. This stream rises in a mountain pass forming the south county boundary and flows approximately north throughout the county. A few miles below its source it enters a narrow valley that gradually widens into a park, one-half mile wide and four miles long. At the south end of this park the stream enters a canon that has so far defied passage to the Colorado railroad-builders, and by any but pioneers and prospectors would have been avoided and accepted as inaccessible for even trails. Today it is traveled over in safety by a good wagon-road, literally cut into one of the canon walls. In places the canon walls stand almost vertical, and the road appears to "hang over" the stream-bed, which is several hundred feet below. This canon is one of Colorado's scenic attractions, the beauty and ruggedness of which must be seen to be appreciated. The Silverton & Red Mountain

Railroad enters the county from the south and terminates at Iron-ton, a mining camp located in the park, at the upper end of the canon. This road co-operates with the branch line of the Rio Grande, terminating at Silverton, and trains are so run that a daylight drive from Iron-ton to Ouray may be enjoyed.

Among the mines that made this county famous are the Virgin-i-us, the Terrible, the Yankee Girl, the Gustun, National Bell, Old Lot, Wheel of Fortune, American Nettie, Camp Bird, Bachelor, Wedge, Atlas, and Bright Diamond. The Atlas mill has installed a flotation process and is making a very high saving of their silver and gold values. The Camp Bird is paying its usual quarterly dividends. The American Nettie Mine is operating principally under the leasing system and making a big output. The Bachelor, Wedge, Atlas, and Bright Diamond Mines also are active and working good returns.

SAN MIGUEL COUNTY

The topography of this county is varied. In the southeast the Uncompahgre Mountains are equally as rugged as in Ouray and San Juan Counties, and have the same geological structure. The east portion of the south boundary is outlined by the San Miguel Mountains, composed of several rugged peaks reaching nearly 14,000 feet in altitude. From the base of the mountain ranges north and west, and embracing about four-fifths of the area of the county, plateaus and broad mesas prevail, composed wholly of sedimentary beds. The drainage of the mountains is northwest through the San Miguel River and tributaries. The west or plateau portion drains north through the Dolores River.

The mesa land and valleys, the latter partially held as gold placers, are sparsely settled, and devoted to stock-growing and to agriculture. The mountainous sections contain the mines. The earliest active operations in both placer and lode claims began in 1875, but, owing to remoteness from market, placer mining assumed greater prominence for a few years, and the gravel beds adjacent to the San Miguel River and tributaries were appropriated for a distance of twenty miles. Later capital was generously employed in equipping these beds with expensive appliances for work on a more extended scale. The results were in the main unfavorable, but the exceptions are still being operated in a desultory way and yielding small annual returns.

The history of lode mining has been one of steady advance from the beginning in 1875.

The important mines in this district are the Smuggler Union, Liberty Bell, and Tom Boy. There have been added two more producing mines in the last year—the Weller Mine and the La Junta. The La Junta has a fifty-stamp mill in operation. It is treating ores by amalgamation, concentration, and cyanidation.

The only large vanadium mill in the state is located in this county. During the past year this mill has doubled its production.

The mill is situated at the town of Vanadium, about eight miles west of Telluride. For the past three years there has been a great deal of prospecting done in the western part of San Miguel County for uranium ores. There are a few mines in this section which have produced some high-grade uranium. There are also enormous bodies of low-grade ores in this part of the county.

MONTROSE COUNTY

Montrose County is one of the western-slope border counties, and its northern portion embraces the Unaweeep section, now attracting attention on account of its copper deposits. Southwest of the Uncompahgre is the San Miguel Plateau. This enters from San Miguel County and extends to the east base of the Sierra la Sal Mountains on the west. This section of the county is drained by the San Miguel, Naturita and Dolores Rivers and tributaries, and embraces the territory most actively mined in this county. The geological structure can at this time only be generalized. Starting on the Uncompahgre River near Montrose, at an altitude of 6,000 feet, one gradually ascends to 10,000 feet, and passes from the Cretaceous into the Carboniferous strata. In other words, while ascending 4,000 feet in altitude, a geological descent of nearly double that distance is made. This can be accounted for only by a slow uprising, incident to the formation of the Sierra la Sal Mountains on the west, accompanied by usual faulting and subsequent erosion; or it may have been the site of a similar eruption local to this section, on a smaller scale, or to both combined. Whatever the cause, the fact exists that, in going up from Montrose across the plateaus to Paradox or Sinbad valley, one, geologically, goes down to the granite and en route crosses nearly all rock types from the Colorado Cretaceous to the Silurian, inclusive.

The west Paradox valley is destined to be the great copper section of Colorado. The La Salle, Cliff Dwellers, Sunrise, Belle of Montrose, and others mines are strong, permanent fissures with well-defined walls. The ore is found in the form of copper glance, gray copper, and native copper and sulphide. Chimneys of very rich silver occur here and there along the strike of the vein.

Montrose County has produced more uranium and vanadium than any other county in this state.

The Standard Chemical Company has just completed a thirty-ton concentrating mill at the Club Ranch on the San Miguel River, for the treatment of its low-grade ores. The National Radium Company has erected a fifteen-ton mill in Long's Park to concentrate the low-grade uranium ores. The larger companies, such as the Standard Chemical Company, the National Radium Company, the General Vanadium, Crucible Steel, Manning, Wilmarth, Marsh, Sullivan Brothers, Galloway, Belisle, Curran Brothers, Cummings & Co., and several others, are shipping nothing but their highest grade uranium ores at present, on account of the European war.

HINSDALE COUNTY

The ores produced in this county are lead, copper, iron, and zinc, in the form of sulphides, carrying gold and silver in combination. Telluride in the form of petzite is found in some districts, gold and silver in natural form are not uncommon, and the high-grade silver ores are often in the form of gray copper, brittle and ruby silver. A portion of the ores occur so that they can be removed and shipped direct to reduction works, but the main portion must be concentrated before shipment.

This county is divided into five mining districts; viz., Lake, Galena, Park, Sherman, and Carson. Lake district embraces the northeastern portion of the county. It extends about three miles west and nine miles south of Lake City. The name doubtless came from Lake San Cristobal, four miles from Lake City on the Lake Fork River. This body of water fills a narrow valley between rather rugged mountains and is one of the most beautiful spots in the state. This district was the one first to attract attention to the San Juan country. Tellurides in the form of petzite occur on Hotchkiss Mountain. The main associate minerals are zinc, lead, iron, and copper in sulphide form. (The composition of petzite is: gold, 25.5, and silver, 40 per cent.)

The mining business in Hinsdale County is improving. There is more inquiry for mining than for many years past, and the number of properties preparing to begin operations is quite significant.

The prospective working of the Golden Fleece Mine under bond and lease (which has already been executed); the steady extension of the drifts from the Ocean Wave cross-cut along the vein each way to develop both the Ocean Wave and the Vermont Mines at great depth; the strike in the La Belle Tunnel in Park district, where a fine body of high-grade copper ore has been opened up at a depth of over 600 feet; the consolidation of all the Carson Camp mines, and the probable construction of a copper smelter next summer to handle the ores, have done much to renew confidence and revive interest.

In addition, the splendid showings being made by lessees in the Independence, Belle of the East, and Fanny Fern Mines, and development of fine ore in the Floosien Boy, Long Taw, and Western Chief, are adding to the proof that the main thing necessary to get a production of ore is intelligent work. While not much showing of output can be made for the coming winter, it is practically certain that another season will witness a very important advance in Hinsdale County's production of the five metals, gold, silver, lead, zinc, and copper. The prospect is very encouraging at the present time.

LA PLATA COUNTY

During the years of 1912, 1913, and 1914 this section has shown greater activity than for many years. The veins occur in

vertical fissures, cutting through the eruptive and sedimentary rock types; also as "blanket deposits" at points of contact between the intrusive diorite and sedimentary beds. The main development is along the fissures, and show some to be of variable width and filled with a quartzose gangue carrying main value in gold. The gold occurs mainly in combination with tellurium, and the value of the ore, in exceptional cases, can be estimated by the pound instead of ton. This character of ore occurs in segregated "pockets" or bunches along the vein at somewhat irregular intervals. The ore value of the vein as a whole is low-grade, but, from reliable information gained, it is sufficient to yield a good profit over expense incident to mining, if properly treated. This promising section, while the first entered in the "San Juan country," has been repeatedly passed over and is today practically undeveloped territory. It possesses all the conditions that have been productive of large and permanent ore deposits in other counties, and there is no apparent reason why it should prove an exception to the general rule. The work now in progress, and that to be prosecuted the coming season, bids fair to add some more permanent producing mines to the already long list of the state.

There were some good silver and copper veins discovered in the Cave Basin district last year; also some good gold ore on Lime Creek. A large deposit of copper ore was struck near La Plata City in 1912, and it has been worked almost continuously since.

James Doyle is running a cross-cut tunnel on the Columbus group to tap the Columbus shaft 700 feet below surface. This is being done for drainage, and to make it safe from snow-slides during the winter. Very rich gold ore was shipped from this property in the early days.

The Valley View is still among the large shippers of this county. There are a great many leasers around La Plata City and May Day, with two to three men in a party, that make occasional shipments of ore, and while each shipment is small, it helps to increase the production of the county. It is my judgment that, when the mines of La Plata County are thoroughly developed, the gold production should equal that of any other county in the state.

DOLORES COUNTY

Rico, the county seat and the principal business center of the county, is situated on the main branch of the Dolores River. The ore bodies of this section occur in both "contact and fissure veins." The best-developed zone shows two systems of fissures, crossing at nearly right angles, with variable dip, and all faulted to a greater or less degree. These are not only intimately connected with each other, but also with the horizontal deposits or "contact veins." In a horizontal direction, the ore bodies are

unusually persistent and have a variable width, from a few inches to thirty feet. Vertically, the values appear to be confined within a few hundred feet of a limestone stratum, locally known as the "contact limestone;" the richer ores occurring near the "contact limestone" and decreasing in value with depth. The system of fissures cutting the strata vertically, and with an approximate north-and-south strike, yields the greater part of the ores produced and carries the highest values.

The ores near the contact are almost "solid" and free from quartz. With depth the percentage of silica gradually increases, until, at the limit, quartz, with little value associated, is found. The better ores in shipping quantities yield 500 to 900 ounces of silver and two to ten ounces of gold per ton. The principal ores found are native and ruby silver, gray copper, brittle silver, and silver glance, associated with galena, zinc blende, and iron pyrite.

Nearer the top of the mountain, or in a zone above the "contact limestone," a system of fissures occurs, enclosing veins made up in the main of galena and zinc blende, but low in gold and silver values. This is also true of a zone lying near the base of the mountains. Neither the upper nor the lower zone is much developed, on account of the low grade of the ore. The ore deposition in the above zones is doubtless intimately connected with the intrusive mass of porphyritic diorite that has elevated this section several thousand feet above its normal position. The different character and value of the ores may be accounted for by different periods of faulting and different times in which certain zones were opened to the circulating waters.

In the trachyte districts both veins and dykes occur similar to those of San Miguel County. Some of the veins are quite extensively developed, and yield good returns in gold, silver, and lead.

Some of the largest bodies of ore are being opened up and blocked out in the Rico Consolidated, Rico Wellington, and Rico Argentine. These mines and numerous others are within two or three miles of Rico. A large amount of ore was shipped in 1913 and the early part of 1914. Since then the price of metals has fallen, and freight and smelting charges are so high that the mining companies have had to reduce their forces to curtail expenses. There is considerable leasing done at Rico, with parties of from two to three men on small blocks of ground. Most of these small leasers are on the Enterprise property. This property is what made Rico famous in the early days.

Dunton, located on the west Dolores River, about sixteen miles west of Rico, is another important mining district.

There are several good mines in here, among which are the Emma, Smuggler, and Rosebud. The Emma is a steady producer, which has been worked under lease for many years and has some very rich ore both in gold and silver. The veins in this district are fissures, with red lime foundation.

Electricity and Mining

By C. R. RUDY
Of The Colorado Power Company

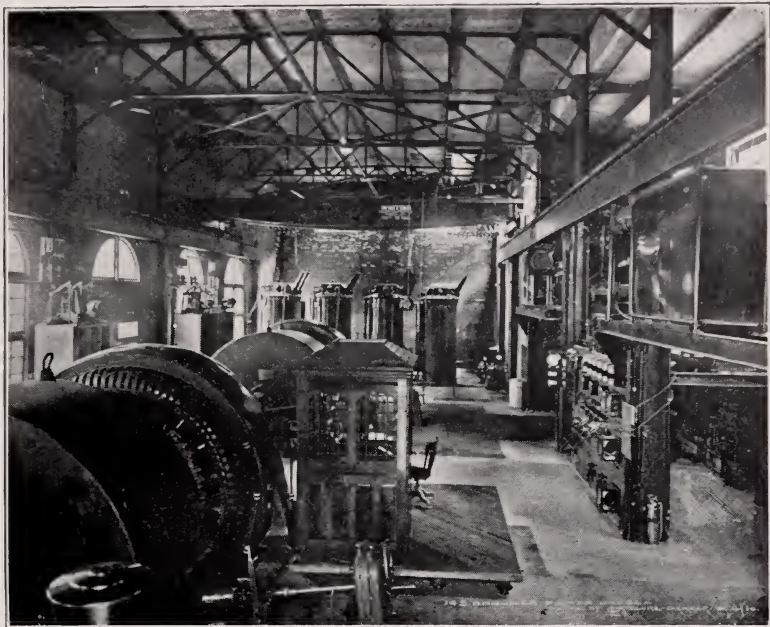
It is universally known that there has been a marvelous advance in the generation and transmission of electricity. More especially is this true with reference to transmission; for in the last few years energy at a potential of 100,000 volts is being transmitted successfully for great distances, and in one instance as high as 150,000 volts is being used for transmission of energy over lines 240 miles in length. Few there are who know that the distinction of having the first 100,000-volt system in operation falls to the lot of Colorado, where it has been proven beyond any reasonable doubt that electric energy can be carried over the mountain ranges at high altitudes without fear of encountering difficulties arising from atmospheric conditions.

Lightning, the one great enemy of the electrical industry, has also been conquered to a greater or less extent; for we are now able, through the installation of properly designed protective devices, to eliminate the possibility of serious interruptions to service. This is of the utmost importance, as a custom power company equipped with duplicate lines and having more than one available power source can now assure its customers a service superior to that obtained from isolated steam plants, which are affected by coal shortages, boiler troubles, difficulty of obtaining water suitable for boiler use, and the numerous other disadvantages encountered through the use of steam.

One of our greatest industries in Colorado to benefit from this remarkable development is mining, and this has received a renewed impetus with the advent of custom electric power.

These two industries are very closely allied; for there is no doubt but that the rapid strides made in the extension of a complete network of transmission lines throughout Colorado and the installation of extremely expensive equipment used for the generation of electric energy would not have been possible were it not for the desirable load obtainable from the mining industry.

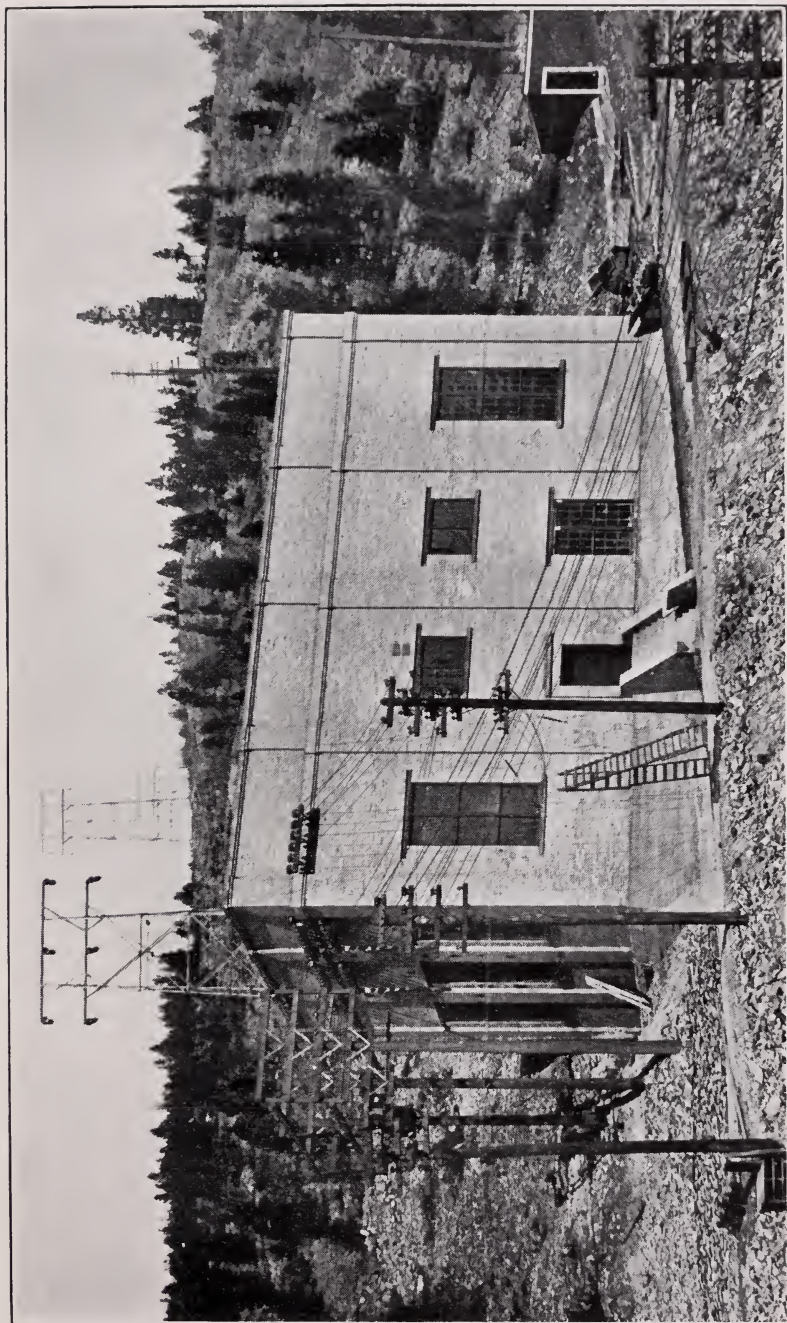
On the other hand, electricity is becoming more and more a necessity in the operation of our mines, owing to its economic and convenient operation, and flexibility. The saving afforded through its use, as compared with steam, ranges from 25 to 75 per cent, depending, of course, upon coal costs and other local



Boulder Power House (Hydro-Electric) of The Colorado Power Co. (Interior.)



Boulder Power House of The Colorado Power Co. (Exterior View.)



Leadville Substation of The Colorado Power Co., Containing Transformers for Reducing Voltage from 100,000 to 6,000.

conditions. Generally speaking, the rates offered by custom power companies will afford a marked saving over the actual fuel cost, and the labor and other items of expense can be reduced in most instances by fully 90 per cent.

Mining men were quick to observe the wonderful advantages afforded through the use of electricity, not only from an economic standpoint, but because they could substitute it for steam for power purposes in every detail, and could apply its use in many ways not possible with steam, with the result that fully 90 per cent of the operating mines are equipped with electric power, if within reasonable distance of a transmission line.

Numerous improvements in electrically driven mining apparatus have greatly facilitated its adoption. Manufacturers have concentrated all their energies upon improvements in this particular line of equipment, having conceded that electricity, through its adaptability, is rapidly supplanting all other power for mining purposes. Electrically driven mining equipment can be purchased for from 25 to 50 per cent less than a steam plant of like capacity.

Few mines today produce relatively high-grade ores, and we are becoming more dependent upon the properties capable of producing large quantities of low-grade material, wherein the margin of profit is extremely small. This necessitates the most efficient operation, and no doubt the best place to start reducing operating costs is in the cost of power. Numerous improvements can be made by the installation of the many electrically driven labor-saving devices which are fast coming into practical use, and consequently the adoption of electricity will accomplish remarkable results. Milling is undoubtedly a very important factor in mining developments, and electricity is extremely well adapted for this type of load, which requires at all times a careful regulation of speed.

In the development of a mine, the generation of power and the mining operations are two separate and distinct features, both requiring expert attention. This is evidenced by the fact that it is difficult to procure a superintendent or manager who is proficient in both lines of work; in most instances either power generation or mining operations suffer for the want of attention, unless custom electric power service is adopted. Its use relieves the manager of all responsibility in connection with his power plant, and he is free to devote all of his energies and ability to the important details of ore-producing.

Owing to many mines being located in inaccessible places, with no railroad facilities or convenient means of transportation, the problem of obtaining fuel during the winter months is a serious one. In many instances large and important producing properties are obliged to close down, awaiting favorable weather conditions. On the other hand, electricity is ever "on the job,"

and work can continue throughout the entire year, with no interruptions because of the lack of power supply.

The Colorado Power Company is the largest custom power company in Colorado, and supplies energy in a territory fed by 150 miles of secondary lines, from substations located on its main 100,000-volt transmission line, which has a total length of 186 miles. Its plants have been in successful operation since 1909. The company's base load plant, of 18,000 horsepower capacity, is located on the Grand River in Garfield County, Colorado, about ten miles east of the town of Glenwood Springs. The power generated there is stepped-up to a transmission potential of 100,000 volts and sent over copper conductors, supported upon steel towers, eastward 158 miles to Denver, through Eagle, Pitkin, Lake, Summit, Clear Creek, and Jefferson Counties. Substations wherein the electricity is stepped-down to a relatively low potential for distribution are located at Leadville, Dillon, Idaho Springs, and Denver. This main transmission line crosses the Continental Divide three times; i. e., at Hagerman, Fremont, and Argentine Passes. In crossing Argentine Pass, the line attains an elevation of 13,600 feet above sea-level. From Denver the line continues north twenty-eight miles, and connects with the Boulder power plant.

The Boulder plant is of 21,000 horse-power capacity, and serves partially as an emergency plant to supplement the Glenwood Springs plant during low-water period of the Grand River. Unlike the Glenwood plant, the Boulder plant is principally a storage development.

In addition to the two hydro plants mentioned above, the company operates an auxiliary steam plant at Leadville, which is always kept in readiness in case of any serious troubles on the transmission line. This steam plant has been in actual service but very few times the last two or three years, as, in case of line trouble, service to Leadville can generally be obtained from either one or the other of the hydro plants.

During the year 1912 there was generated in the entire State of Colorado approximately 160,000,000 kilowatt hours, and of this amount the Colorado Power Company generated approximately 84,000,000 kilowatt hours.

Nowhere in the United States is there a company better equipped to supply its customers with continuous and well-regulated service.

The company has during the past year supplied power to 152 mining, milling, and smelting companies requiring that interruptions shall be only of few minutes' duration. More especially is this true in connection with companies operating blowers used in ore-smelting, or pumps which are depended upon to keep the mines free from water, as in many instances a serious delay in the operation of these pumps means the expenditure of thousands of dollars in the recovery of the mines.

Of interest at this time is the proposed operations of the Down Town Mines Company. This company has secured leases on some 400 acres of valuable mining property, which comprises what is known as the Down Town Mines in Leadville. These properties have been under water since 1907, and a majority of the shafts are in such condition that no mining or unwatering can be undertaken through them. The Down Town Mines Company proposes to unwater this entire district and is confronted with the problem of delivering, during the unwatering period, approximately 3,000 gallons of water per minute against a total head of 825 feet. This unwatering must be done through the only available shaft, known as the Penrose, which contains three compartments, one of which is five feet six inches by four feet six inches; the other two being of equal size—viz., four feet six inches by four feet. This presents a difficult problem, and a great deal of time and study has been devoted to determining the power and equipment best adapted to this work. It was finally decided that electricity was best suited for this duty, and the company has therefore placed orders for four 1,500-gallon, two-stage, vertical, centrifugal sinking pumps, good for a total head of 450 feet. These pumps are each equipped with 300 horse-power, 1,800 R.P.M., 550-volt vertical motors. It is the plan of the engineers to lower two of these units, one in each of the outside compartments, leaving the central compartment clear for a hoist-way, to a station which is to be cut at about the 425-foot level, where they are to be set into a station. From this 425-foot level the two remaining units are to continue down the shaft and discharge the water to the first two units, which will relay it to the surface.

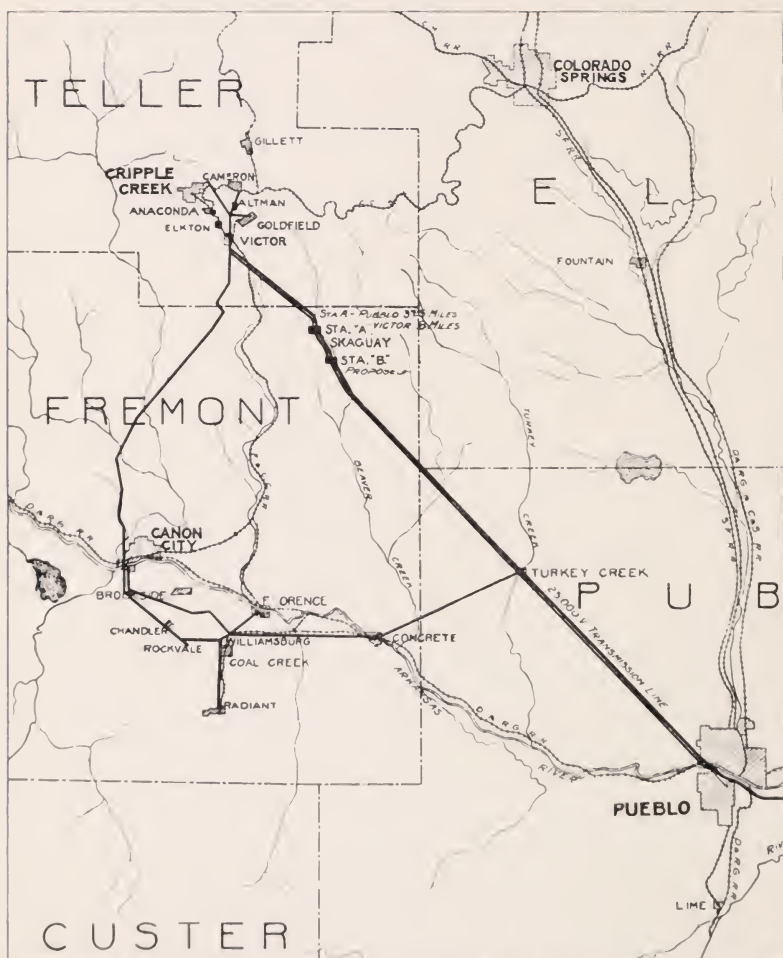
The actual work of unwatering is to start about February 1, and will require three to four months, at the completion of which the normal flow, it is estimated, will be about 1,500 gallons per minute.

This undertaking is particularly interesting in view of the fact that it is the first unwatering project in Colorado, of such magnitude, that has been undertaken with the use of electric unwatering pumps, though their adoption is far from being an experiment, as great advances have been made in the development and use of this class of equipment in the last few years.

The Colorado Power Company has contracted to supply the electric power service for the entire operations of the Down Town Mines Company and is at present installing four 300 kva transformers to take care of the total load of approximately 1,400 H.P. Connection to the company's substation and steam plant is made by three separate circuits, thus avoiding any possibility of interruption occurring from line trouble. The steam plant located at Leadville is to be kept in readiness to handle the entire load in case of serious trouble to the company's high tension lines.

The Salida Light, Power and Utility Company, which is owned and controlled by the Colorado Power Company, serves the town of Salida and the Monarch Mining District. The plant is at Salida.

In conclusion, it is the opinion of the writer that electric power service has already radically changed mining operations for the better, and there seems every reason to anticipate that the availability of custom power service throughout the state will not only continue to afford a possibility of cheaper and more continuous mining operations, but will ultimately attract new mining enterprises of various kinds.



Map of the Part of The Arkansas Valley Light & Power Co. System Which
Serves the Mining Districts.

The Arkansas Valley Railway, Light and Power Company

By W. F. RABER
Vice-President and General Manager

The Cripple Creek gold-mining district, the coal fields near Canon City, and the Florence oil district are served with electric power by the comprehensive transmission system of the Arkansas Valley Railway, Light and Power Company.

It is asserted that electric power for mining and ore-reduction operation is sold cheaper in the Cripple Creek district than in any similar field in the country. Experts have estimated the cost from 25 to 50 per cent less than steam power produced from coal at the mills and mines. This low-priced power service has enabled mining operations which would not otherwise be profitable or possible.

The Arkansas Valley Railway, Light and Power Company is a consolidation, unification, and improvement of several predecessor power companies operating in separate territories. It was formed in 1911 by H. M. Byllesby & Co., engineers and managers, of Chicago. The headquarters are at Pueblo, in charge of W. F. Raber, general manager. Pueblo is near the center of the transmission system, which extends a distance of forty-five miles from Cripple Creek on the northwest to La Junta, sixty-five miles on the southeast, with a western loop running southward from Victor to the mining district of Canon City, and thence eastward toward Pueblo, approximately sixty miles.

The entire property under the expert engineering and commercial direction of Byllesby & Co. has been vastly improved in many ways, but chiefly in the construction of seventy-five miles of high-tension transmission lines, which have greatly enlarged the scope of the company's operations, and materially improved the quality and continuity of service. The property now represents an unusually high degree of efficiency and public usefulness, not only to the mining industry, but to the many cities, towns, agricultural districts, and other industries served.

The general policies of the company are definitely public-spirited, and based on the theory that fair and even-handed reciprocity must accompany all transactions which yield lasting benefits to the parties thereto.

The power production and distribution system of the Arkansas Valley Railway, Light and Power Company includes three principal power sources, as follows:

Skaguay hydroelectric station.....	1,300 K. W. capacity
Pueblo steam station.....	5,260 K. W. capacity
Canon City steam station.....	4,700 K. W. capacity

The total electrical generating capacity is 11,260 kilowatts, or 15,000 horse-power. The steam stations have both turbine and reciprocating engine equipment. The hydroelectric plant is located on Beaver Creek, about five miles southeast of Victor, and is operated under an effective head of 1,160 feet, water being supplied through a pipe line from a reservoir of 140 acres, obtained by the construction of a dam 83 feet high and 400 feet long.

The transmission system consists of 170 miles of 25,000-volt pole line, of which 42 miles, between Victor and Pueblo, carries a duplicate circuit. There are 70 miles of 13,000-volt secondary transmission lines, and 210 miles of local distributing lines.

Any or all of the three power stations may supply current to the transmission lines at one time, two of these three power sources being located close to the mining districts served. A load dispatcher is located at Canon City, all of the high-tension lines being under his control. Private telephone lines traverse the whole system, which is regularly patrolled.

This company serves a total of twenty-five municipalities, with a total population of 85,000, with electric light and power. It also owns and operates the street-railway system in Pueblo. For operating purposes the territory served is subdivided into three divisions, these divisions being shown below, together with the principal communities embraced.

Pueblo Division:

Pueblo, Vineland, Avondale, Blend, and environs.

Mountain Division:

Canon City, South Canon, East Canon, Lincoln Park, Victor, Cripple Creek, Goldfield, Lawrence, Florence, Coal Creek, Rockvale, and other towns and environs.

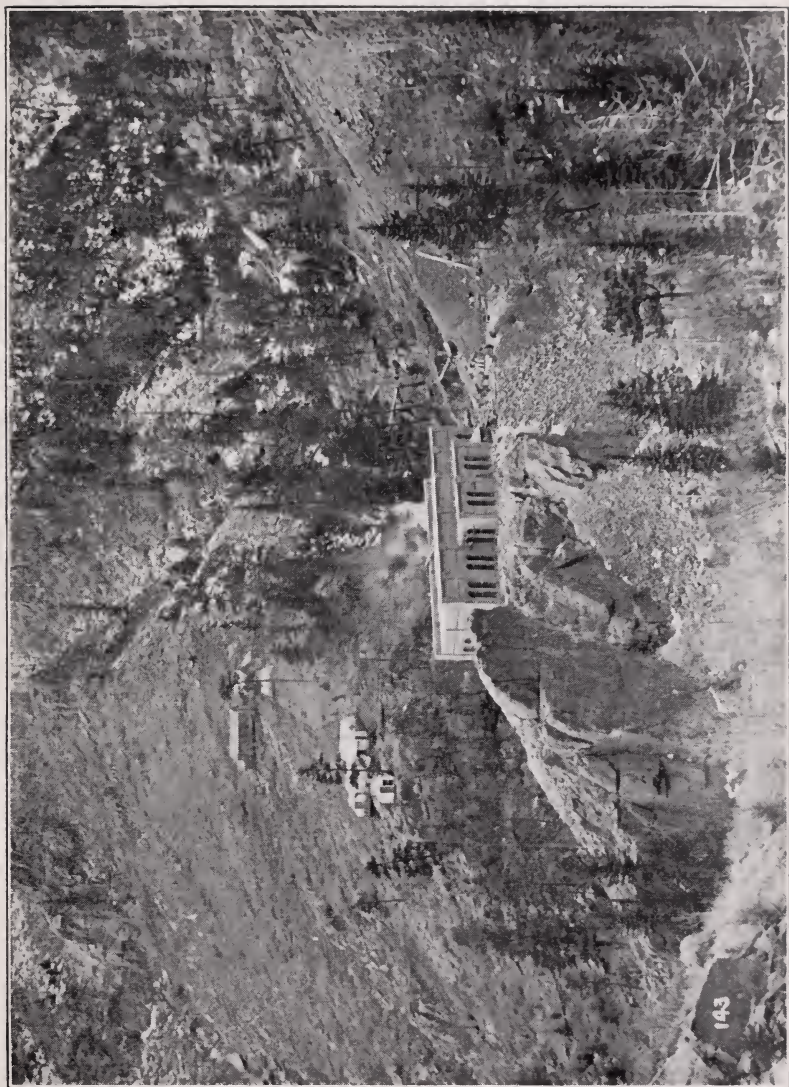
Valley Division:

La Junta, Swink, Rocky Ford, Fowler, Manzanola, Ordway, and Sugar City, and environs.

Electrical output of each of these divisions during the calendar year of 1913 was as follows:

Pueblo and Valley.....	14,073,101 K. W. H.
Mountain Division.....	30,268,617 K. W. H.

Total output..... 44,341,718 K. W. H.



Skaguay Power Plant, Skaguay, Colo. The Arkansas Valley Railway, Light & Power Co.

In the gold-mining operations the company serves a total connected motor load of 8,300 horse-power, of which 3,200 horse-power serves ore-reduction mills and 5,100 horse-power serves mining operations. In the Canon City coal-mining district a connected load of 4,857 horse-power is served in the mines and mills.

All of the ore-reduction mills in the Cripple Creek district are operated by the electric power service of the company. The cost of power for ore-crushing varies from 5 to 10 cents a ton. Of these mills the largest are the Portland Mill, with 1,400 horse-power connected; the Independence Mill, with 1,100 horse-power, and the Ajax Mill, with 400 horse-power. In the gold-mining operations electricity is used for driving hoists, drills, compressors, pumps; in fact, all kinds of machinery formerly operated by steam. The number of electric hoists in use is now in excess of fifty, ranging from 5 to 50 horse-power capacity each. A number of the mines use electrically operated tram cars for hauling ore and waste, and for running saw-mills, machine shops, etc. The largest electric pumps in the district are installed in the Golden Cycle Mine, pumping from a 1,600-foot level to the surface.

From the three principal substations in the Cripple Creek district three-phase, thirty-cycle alternating current is distributed at 500 or 6,600 volts. The larger mines and mills have individual substations, taking current on their high potential sides at the main-line pressure. Power from the system is used also to operate an electric railway connecting the various camps.

All the large coal mines of the Canon City district purchase electric power from the company, as they find it cheaper to do this than to make their own power on the ground. Power is used in the coal mines for hoisting, operating, ventilating fans, pumping, etc. The largest electric hoist at present installed is a 250-H.P. unit at the Coal Creek Mine of the Colorado Fuel and Iron Company.

Down Town Drainage, Leadville

Leadville, one of the most resourceful mining camps in the United States, inaugurated a new movement in 1914 which should add tremendously to its output. Operations are now under way to unwater the mines of the down-town district, comprising fifteen of the most important older properties and 400 acres of undeveloped territory. This is the largest enterprise launched in the Leadville district in many years.

After the panic of 1907 these mines were shut down, and have since remained idle and flooded with water. They had produced \$12,000,000 in silver, lead, iron, and manganese during their years of development. That a carbonate ore, which was being thrown on the dumps of the Leadville district, contained a high percentage of zinc was not discovered until 1910, three years after these mines were shut down.

Although Leadville had always been one of the greatest producing mining camps in the state, the discovery of zinc doubled its output of the last five years. The zinc production of 1913 in Leadville was nearly \$5,000,000. Carbonate of zinc is known to exist in the down-town district, and several lots have been shipped from the Penrose dump.

The Penrose shaft has been sunk 875 feet to the Cambrian quartzite, but most of the other mines embraced in the project had attained a depth of only 600 feet. It is planned to drain the mines to the depth of the Penrose shaft (875 feet) and develop the ore bodies above.

The Down Town Mines Company, which is conducting the work, was organized by Hon. Jesse F. McDonald, former governor of Colorado, a mining engineer of wide experience, particularly in Leadville.

This company entered into contracts with the owners of the mines to lease their properties for a term of twenty years. As the owners were scattered over two continents, the task of locating them and securing their signatures to the contract was not accomplished until after a year of tedious and patient work. The company is incorporated with a capital of \$300,000, but it is not believed that all the capital will be used. The full amount of stock has been subscribed by St. Louis and Flat River (Mo.) district mining financiers familiar with this class of projects.

Operations will be conducted through the Penrose shaft, which is centrally located, and 41½ by 15 feet in size, 875 feet deep to the lowest level.

A contract has been made with the Providence Engineering Works for the delivery of two centrifugal sinking pumps, each

of 1,500 gallons per minute capacity for 450 feet head, and for two relay station pumps of the same capacity; also with the General Electric Company for four motors of 300 horse-power each, to run the pumps.

Power will be furnished by the Colorado Power Company from its hydroelectric plants at Shoshone and Boulder, and from its steam plant in California Gulch, less than a mile from the Penrose shaft; thus giving three independent sources of supply.

Each sinking pump and motor is to be mounted in a steel frame, with shoes to fit the guides for cages in the shaft.

The normal flow of water in the Down Town Basin is 1,500 gallons a minute, but the area of the basin and mine workings is so great that it will require several months' continuous pumping to drain the district before mining can be resumed.

A fire-proof transformer house is nearly completed, contracts have been let for electrifying the hoisting engine, and all surface improvements are being pushed as rapidly as possible, preparatory to commencing pumping operations early in 1915.

The Colorado School of Mines Experimental Plant

By WILLIAM GEORGE HALDANE, Acting President

Cheap and economical processes are needed for handling the low-grade quartz veins prevalent over the whole western country: the complex zinc, iron, and lead sulfides of the San Juan and Montezuma districts; the zinc carbonates of Leadville; the low-grade tellurides of Cripple Creek; the lean ores of Clear Creek and Gilpin Counties; the carnotites of San Miguel, Montrose, and Dolores Counties.

The economic handling and marketing of our great variety of coals, from lignites to the best semi-anthracites, is deserving of our most serious consideration.

The solution of these problems means the unlocking of immense wealth to the state, and the stimulation of one of our basic industries.

The necessity for higher efficiency in the treatment of our ores has, within a few years, become apparent to a number of the larger mining concerns, resulting in the organization of testing and experimental departments whose sole duty is to improve details and eliminate unnecessary steps in the process involved. These departments have more than paid for themselves in every instance and have demonstrated the wisdom of the innovation beyond peradventure of a doubt. However, these efforts and developments have not reacted to the benefit of the small operator; and, in an attempt to assist the general mining public, the legislature, a few years ago, appropriated \$75,000 for an experimental plant for the School of Mines; which amount was later increased by a further appropriation of \$50,000 by the next legislature. However, only one-half of the latter was paid.

The building, covering an area of 98 by 142 feet, is of steel construction, with cement walls of hy-rib reinforcement. Power is supplied through an 80-K.W. Westinghouse gas engine generator set, installed in the school power-house. The water supply is obtained from Clear Creek, being pumped from a well sunk near the bank to storage and supply tanks at the head of the mill.

FUNCTIONS OF THE PLANT

The general function or purpose of the school is to conduct, in behalf of the public welfare, such investigations as will lead to an increase in the efficiency and economy in the mining, mill



Colorado School of Mines, Experimental Plant, Golden, Colo.

ing, and reduction of our mineral reserves. This may be called the research feature. Members of the faculty and expert investigators along the various lines of ore treatment are provided with facilities and opportunities for carrying on research and original investigations in connection with the handling of ores typical of a whole district.

Educational Feature

The plant is also designed to serve as a laboratory to the students in attendance at the school. While these young men, through the advantage of the school's location, are required to take numerous inspection trips to the mining and milling centers of the state, to supplement the theoretical or class-room work, such trips fulfil only partly the ends desired. They have no opportunity to make detailed study of apparatus or process, and no facilities for making comparison of the efficiency of various machines under like condition.

With the great variety of equipment at the Experimental Plant, typical crushing equipment, such as jaw and gyratory breakers, may be studied, their principles made clear, and comparison as to efficiency, power required, nature of product, etc., worked out under the supervision of instructors.

The various methods of concentration by jigs, tables, and flotation schemes likewise are studied by actual operation. In a trip through a commercial mill the student sees a concentrating-table in operation under presumably most economical conditions, and while he may time the number of strokes per minute and measure the length of stroke, he has no means of determining the effect upon results of variation in speed, length of strokes, pulp and water feed, and slope of table.

With the facilities offered by this splendid laboratory, the efficiency of the class-room work is greatly increased, and these young men go out into the field of commercial work better equipped than those from any institution in the world.

Commercial

In addition to the educational and research features, the plant also provides facilities for the commercial testing of ores in lots up to carload size.

While arrangements can be made to have such work done under the direction of the school authorities, it is generally expected that the owner of the ore, or his expert, will assume charge of the tests. The expense of such work varies with the nature and extent of the tests.

It is not the intention of the school to compete with private enterprise in this feature of the plant, but rather to stimulate and co-operate with such interests.

EQUIPMENT

For convenience, the plant is divided into several units, with such flexibility between units and parts of individual units as will permit of the greatest leeway in disposal and treatment of products from various machines. The several units are as follows: sampling; concentrating; cyanide; special apparatus; chemical laboratory.

The general equipment consists of an air compressor for agitation and cleaning of dry machines, pumps, elevators, dryers, track scales, supply tank, and ore bins.

The sampling section contains Vezin and Brunton samplers, rolls, feeders, laboratory crushers, pulverizers, and cutters.

The concentrating unit shows a great variety of equipment as evidenced by the following list: Blake Jaw Crusher, 7 x 10; Gates Gyratory Crusher, 2 D; P. & M. M. Co. Rolls, 14 x 30; P. & M. M. Co. Rolls, 12 x 24; Huntington Mill, 3½ feet; Akron Chilean Mill, 4 foot; Richard's Pulsator Jig, 12 x 12; Hartz Jig, one compartment; Traylor All-Iron Jig, four compartments; Wilfley No. 6; True Vanner, Allis Chalmers suspended type; Deister Slimer, No. 3; Deister Sand Table, No. 2; Pulsator Classifier; Spitzkasten.

In addition to these, this unit is equipped with a Callow miniature testing set, quarter-sized Wilfley and Card tables, experimental flotation apparatus, Callow cones, screens, etc.

A five-stamp battery, with amalgamating plates, clean-up pans, and accessories, is also provided.

The Cyanide unit consists of the following: Tube Mill, 3-foot, silix-lined; Pachuca Agitator; Dorr Classifier; Dorr Agitator; Dorr Thickener; Butters Filter; Moore Filter; Paterson Agitator; and, in addition, thickening cones, solution tanks, zinc boxes, acid tanks, filter press, and the necessary pumps and accessories. This unit is also equipped with small-scale apparatus for preliminary tests.

Under the head of special apparatus should be mentioned a Ruggles-Cole Dryer, Wilfley Annular Roaster, Ding's Magnetic Separator, and a small Plumb pneumatic jig.

With the many problems awaiting solution, and the splendid facilities offered by this plant, it is hoped that the authorities will not be hampered, through lack of funds, in making it serve all the functions above enumerated.

No state has such a wide diversity of mineral wealth, and in no state is the need of scientific and technical investigation more felt than in Colorado.

What is aptly termed "western metallurgy" is anxiously waiting and ready to utilize all the advances made in technical research.

The Mary Murphy Gold Mining Company Mill (Chaffee County)

By GEORGE E. COLLINS, General Manager

The Mary Murphy mill was built in 1912, to treat the ore from the well-known mine of that name, which was discovered in 1874 and has been largely productive since 1879. The mine consists of a complex system of fissure veins, cutting steeply through quartz-monzonite; the principal of which, the Mary vein, has been opened through a vertical height of 2,000 feet.

The ore minerals, arranged in order of quantity, are zinc-blende, galena, pyrite and chalcopyrite, with cerussite, anglesite, and a little malachite and native sulphur in the oxidized zone; the depth of which from surface is irregular, and varies with different veins. The gangue, in the upper levels, consists of rhodonite and quartz, with a little calcite. In the lower levels it consists mainly of quartz and clay, with calcite and a little fluorite. Gold occurs both in the ore and gangue minerals, but decreases in amount, and becomes strikingly irregular in distribution, in the deeper workings. Silver also occurs both in the ore and gangue minerals, and lessens in quantity with depth to a greater degree even than the gold.

The ores are very difficult to concentrate satisfactorily, for the following reasons:

1. The gold and silver are intimately associated with the gangue, as well as the sulphide minerals.

2. The rhodonite has nearly the same specific gravity as the blende and chalcopyrite, so that concentration is only possible on account of the difference in form and size of particles. The rhodonite is so hard and tough that it does not grind so fine as the other minerals, and so is washed off into the tailing (and still more into the middling) by the water film employed in concentration.

3. The sulphide minerals are usually finely disseminated through the gangue, and intimately intermixed. Mineral particles 200-mesh in size, when examined through a microscope, show a large percentage of included grains. For instance, what to the eye, or even to a low-power lens, seems to be clean zinc-blende is shown by the microscope to contain innumerable minute inclusions of galena, pyrite, or chalcopyrite. A perfect separation is therefore impossible by any mechanical method.

The ore bodies are irregular, and individual stopes cannot be depended on. To maintain an output of 200 tons per day (175 tons of milling ore and about 25 tons of smelting ore), a great number of working places must be maintained—probably more than with any other mine in the state. The ore mined during the present year has been derived from all levels between the surface and No. 14—a vertical range of 1,200 feet.

The original intention was to remove the sulphide minerals by concentration, and cyanide the tailing. Elaborate experiments have, however, shown that, while a fair extraction of the gold, and even of the silver, can be made by cyanidation after very fine grinding, the cyanide consumption is inordinately high, due to copper, which, although present in small percentage (about 0.75 per cent in the samples on which the preliminary tests were made), is extremely soluble. No economical method of overcoming this difficulty has yet been devised, but experiments are still in progress.

To meet this condition, the mining methods have been modified to permit of close selective mining, whereby the high-grade ore, especially the oxidized ore and that carrying high silver values and low zinc percentage, is mined separately for direct shipment. In this way an average of about one carload per day of high-grade smelting ore is produced, the returns from which are almost equal to those from mill products.

The mill was designed by Mr. Franz Cazin and the writer, and, while intended to handle a tonnage of 100 tons daily, has been subsequently developed by slight changes so as to treat 175 tons. The ore is drawn from bins holding 300 tons, to which it is delivered from the mine by an aerial tramway of Bleichert type, on a conveying and sorting belt 22 inches wide, which delivers to a grizzly spaced at one inch, the oversize from which passes to a Blake crusher, 13 inches by 24 inches, after which it joins the undersize, and both are raised by a belt-bucket elevator to a double trommel, the inside plates of which have $\frac{1}{2}$ -inch round holes, and the outer $\frac{1}{8}$ -inch by $\frac{3}{8}$ -inch slots. The coarse screen oversize is spouted to coarse rolls, and the fine screen oversize to fine rolls—the ultimate product all passing the $\frac{1}{8}$ -inch slots. Both sets of rolls are 40 inches by 16 inches, of Colorado Iron Works Standard type. Below the fine rolls the ore-stream is cut by a bucket carried by a double chain, and after recrushing in a 12x12 set of sample rolls, the first cut is again cut by another similar bucket, thus cutting out a sample which forms a definite portion of the entire feed, and so enables a fair estimate of the tonnage to be made.

The ore, dry-crushed as above described to $\frac{1}{8}$ inch, is delivered on a conveyor belt 18 inches wide, and by it carried to four equalizing bins, each of 100 tons capacity, where it is discharged by a traveling tripper. The crushing end of the mill can handle 100 tons per shift of eight hours, and is now run two shifts.

From the equalizing storage bins the ore is removed by oscillating feeders, where another sample, which forms a definite fraction of the total feed to the concentrating plant, is taken by hand. The stream falls on another 18-inch conveyor belt, which carries it to a belt-bucket elevator, by which it is raised to the top of the mill, where it is first mixed with water. Here a duplex trommel with 1 mm. round holes separates it into two classes, which are separately classified, and treated on two separate, but similarly equipped, sides of the mill.

The 1 mm. undersize contains all the natural fines produced by mining and handling through several hundred feet of chutes, and also those resulting from the crusher and rolls. It is classified into six classes by five Richards pulsating classifiers (launder type) and a 4-foot Callow cone. The sands are concentrated by five Card tables, and the Callow cone spigot by two Deister slimers. The Callow overflow joins the muddy water from the tail end of the tables, is thickened by an 8-foot Callow cone, and concentrated on the next floor by Monell tables.

The Card tables make four products: lead concentrate for shipment, zinc-iron-copper concentrate for electrostatic separation, and both a lead-zinc-iron-copper middling and siliceous middling for retreatment on tables. The coarse sand from the two first tables is returned to a tube-mill for regrinding. The two retreatment middlings from the upper tables are together treated on Card tables on the lower floor, making a small quantity of lead concentrate; also clean zinc-iron-copper concentrate for separation, middling for regrind, and tailing.

The Deister tables make lead concentrate, zinc-iron-copper concentrate for static separation, siliceous middling which is retreated on a single Deister on the lower floor, and tailing.

The Monell tables—a Colorado-made machine consisting of an endless canvas, rubber-covered belt with a transverse shake, similar to the Lührlig vanner—make a marketable lead concentrate, and a siliceous zinc concentrate, which is retreated on a Wilfley on the bottom floor; which latter is fitted with special shallow metal riffles, and makes a little more clean lead concentrate, and clean zinc-iron-copper middling. The tailing from this machine is returned to the system. The above description applies to the north end of the mill.

The oversize from the 1 mm. trommels at the top of the mill is run over a duplex two-compartment jig, the first compartment of which makes clean lead concentrate. The second compartment by hutch and side discharge separates the feed into two classes: (a) heavy mixed mineral particles, and (b) light gangue containing a small quantity of very finely disseminated mineral.

The former is piped to a set of 14-inch by 27-inch Walker rolls, by which it is crushed in a close circuit to pass through a wet Newaygo shaking screen, 20-mesh. The pulp so produced is divided between two Card tables on the middle floor. Here a

large quantity of coarse clean lead concentrate is taken out, which is mixed with the jig lead; and coarse zinc-iron-copper concentrate for the separating plant. The middling from these tables is returned to the Walker rolls, and all the tailing to the tube-mill for fine regrind.

The tailing (b) from the jig is spouted to two 6-foot by 22-inch and one 4-foot by 15-inch Hardinge mills, silex-lined, using local river-bed pebbles. After grinding, the pulp passes over tables, the upper half of which are covered by amalgamated copper plates and the lower half by carpets; and thence to a duplex belt-and-bucket elevator, which elevates the pulp from these pebble-mills, and also that from the tube-mill hereafter described, to the top of the mill. Here it is classified and concentrated by machines arranged almost exactly the same as those already described as in the north end of the mill, making similar products, except that the proportion of concentrate is less, and that it is much finer.

The tube-mill previously referred to is of Allis-Chalmers make, 3½ feet by 16 feet, fitted with El Oro lining and filled with local pebbles. It receives a feed consisting of the coarse table tailing, of various middling products already referred to, which have been dewatered by a drag classifier, together with a portion of the dewatered jig tailing (b). Its product also discharges to the duplex elevator, with those from the Hardinges, and is concentrated on the south side of the mill.

The carpet strakes below the Hardinges are washed at intervals depending on the amount of free gold in the ore, averaging twice per shift, into tubs. The concentrate in these tubs is ground with quicksilver in a silex-lined arastra, with a stone drag and steel cover provided with padlocks. The overflow is drawn off into a series of settling tubs, and the amalgam removed through a hole in the bottom. With the carpet concentrate is ground the product from the first few riffles of the sand tables, which often contains considerable free gold; this being piped direct into the arastra.

Even with these precautions to remove free gold, it is difficult to obtain concordant samples of the lead concentrates. Most of the gold, when free, appears to be very fine, and it is a singular fact that, notwithstanding the large aggregate gold production of the mine, and the great richness of some of the ore, no specimen showing free gold has ever been seen in it. Mine samples, assaying as high as 42 ounces of gold have been panned without showing free gold, but tests have not shown the presence of tellurides. Yet at intervals nuggets of gold, or gold mixed with quartz, in sizes ranging from 1/20 to ½ inch diameter, collect on the jig-screens, and even in the trommels of the crushing-plant. The crude bullion produced by amalgamation is not large in quantity, and consists of gold and silver in approximately a proportion 3:2.

The entire mill tailing is automatically sampled by a tilting sampler, and runs to two large tanks outside the mill, with spigot discharge and peripheral overflow. The spigot discharge, containing over 80 per cent of the solids, is stored in large tailing-dams below the mill. The overflow, consisting of the finest slime, is conveyed by a long launder with $\frac{1}{2}$ -inch holes, where it is spread out along the hillside, and settled in a great number of small slime ponds, with a view to clarifying the discharge as much as possible, and minimizing the discoloration of the creek into which it finally makes its way.

This disposal of the tailing has always been a source of very great expense, the number of men required being never less than two, and often four or five, besides the cost of logs and lumber for the dams, burlap, etc. The total expense has certainly averaged 15 cents per ton of ore treated. Nevertheless, various persons at Salida have raised a great outcry about the supposed damage to fish caused by the mill operations, and have endeavored to secure action from county and state officers, with a view to the closing-down of the mill by injunction. It is safe to say that no other concentrating plant in the state takes such precautions to avoid stream pollution; and that, if the Mary Murphy Mine is interfered with on this account, the entire milling industry of the state will be threatened.

The power for the entire mill is generated by steam, a tandem compound Corliss engine rated at 260 H.P. running the mill and also a Leyner air-compressor. Steam for the engine and for a steam-driven Rand compressor is generated by two Scotch marine boilers with Morrison corrugated furnaces, each rated at 125 H.P., carrying 140 pounds pressure. Another horizontal tubular boiler is kept in reserve, and can independently supply either the Rand compressor or a Norwalk compressor reserved for emergency use. All exhaust is discharged to an Alberger surface condenser, which maintains a vacuum of about 19 inches.

The zinc-iron-copper concentrate made in the wet mill is practically unmarketable in that condition. It is separated into commercially valuable products by electrostatic machines, in what is called the static mill. This is located below the main mill, to which it is connected by a movable bridge across the lower railroad track, and on the level of the lowest floor of the wet mill.

In this the ore is dried by a revolving cylinder, with a fire-box at one end and a fan at the other, in which the ore travels from the cool to the fire end. This drier is heated by wood. From it the still hot ore is elevated to a Newaygo vibrating screen, where it is screen-sized to the equivalent of about + and — 80 mesh. From the screen the coarse is fed to one Huff toboggan machine, and the fine, by a rod-and-scraper conveyor, to three others. The products fall through a hopper to the bottom floor, where they are received in large steel cars and conveyed by a

platform elevator, actuated by compressed air, to the level of the loading floor, where they are loaded into railway cars.

During October, 472 tons of zinc middling were treated in this plant, yielding products as follows:

	Tons	Au.	Ag.	Pb.	Zn.	Cu.	Fe.	Insol.
Feed	472.0	.47	5.8	10.0	34.6	2.2	12.2	...
Zinc concentrates.....	337.1	.45	5.0	7.3	46.5	0.7	4.5	6.3
Lead-copper concentrate.....	161.3	.57	7.5	13.3	13.7	4.8	24.7	7.1

The static plant is usually run two shifts daily. Its capacity may be stated as approximately one ton of finished product per hour.

During the month of October, 1914, 4,442 tons of dry ore were milled, assaying as follows:

Gold, 0.28 oz.; silver, 2.7 oz., per ton; lead, 4.7% ; zinc, 8.0% ; copper, 0.5%.

The average tailing assay was:

Gold, 0.09 oz.; silver, 1.6 oz., per ton; lead, 1.2% ; zinc, 3.2% ; copper, 0.2%.

This shows a saving as follows:

Gold	72.0%
Silver	47.9%
Lead	77.7%
Zinc	65.1%
Copper	65.1%

The copper in the zinc concentrate, and the zinc in the lead-copper concentrate, are not paid for; so it will be readily seen that the commercial saving is even lower than the technical saving. There is a large margin for improved methods in the treatment of complex ores, such as these, particularly in the direction of electric smelting, so-called "dry" chlorination, or possibly even wet chemical processes. The combination of methods in use at the Mary Murphy represented the best possible attainable at the time the plant was designed, and perhaps even the best commercial result possible today. But the writer is confident that eventually these methods will be superseded by others which will enable a saving of larger percentages of the various metals to be made. Such methods, however, will probably require to be preceded by wet concentration, with or without flotation, and the design of the mill is especially planned to admit of a wide range of modification, while the parts of the plant least likely to become out of date are those which, with this possibility in view, have been most substantially constructed.

Various experiments are being made with a view to the treatment of the concentration tailing by flotation. These tests



Atlas Mining & Milling Co., Mill, Ouray, Colo.



Camp Bird, Limited, Mills, Ouray, Colo.

are encouraging as to the possibility of making a salable product from the tailing; the doubtful point is as to the commercial side—i. e., whether the value of the product will pay the cost of the operation and initial cost of plant, particularly at existing metal prices. From what has been said already it will be evident that flotation can do but little to reduce the losses of gold and silver, which are locked up in the gangue minerals.

The Atlas Mining and Milling Company Mill (Ouray County)

By FRED CARROLL, Manager

The general design and flow sheet of this mill are very different from any in Colorado. The ore is received from the mine over a short Bleichert tramway, carrying buckets of 8 cubic feet capacity, which are dumped into a hopper leading to a 30" x 10' revolving screen with 1½-inch perforations. The undersize falls directly into a bin behind the stamps, and the oversize is discharged onto a 30-inch pan conveyor, which carries the ore past an ore-sorter, who removes barren rock and selects suitable-sized quartz to be used as a grinding medium in a Hardinge pebble mill. The pan conveyor discharges into a No. 5 Symonds crusher, from which the ore is distributed by a belt conveyor in the bins back of the stamps.

The ore is stamped through 6-mesh screens, then classified, the oversize fed to a 22" x 8' Hardinge mill, and the undersize, by-passed to join the reground sands from the Hardinge mill. The pulp ground to pass an 80-mesh screen is fed to an eight-compartment Minerals Separation froth flotation machine, where it is treated by the cold non-acid process.

The concentrates are skimmed and, after dewatering and drying, are shipped to the smelters. The tailings from the flotation machine are passed through a hydraulic classifier, and the spigot flow taken onto a No. 4 Deister table, where some of the coarser minerals are concentrated which the flotation machine does not recover.

Some alterations of the plant are now being made which will extend the treatment somewhat.

Golden Cycle Mill (Colorado City)

By JOHN TAIT MILLIKEN

Consulting Engineer of the Golden Cycle Mining Company

The Golden Cycle Mill, situated near West Colorado Springs, was originally planned to treat the ores of the Golden Cycle Mine and the other properties controlled by the Golden Cycle Mining Company; but ere the original plans were carried out, the field for a thoroughly equipped and up-to-date milling plant, employing the cyanide process, for the handling of custom ores originating in the Cripple Creek district, was so attractive and inviting that a cyanide plant, having a capacity of 1,000 tons per day, was constructed. This plant has recently been enlarged to 1,150 tons per day, and is today handling over 80 per cent of the output of Cripple Creek.

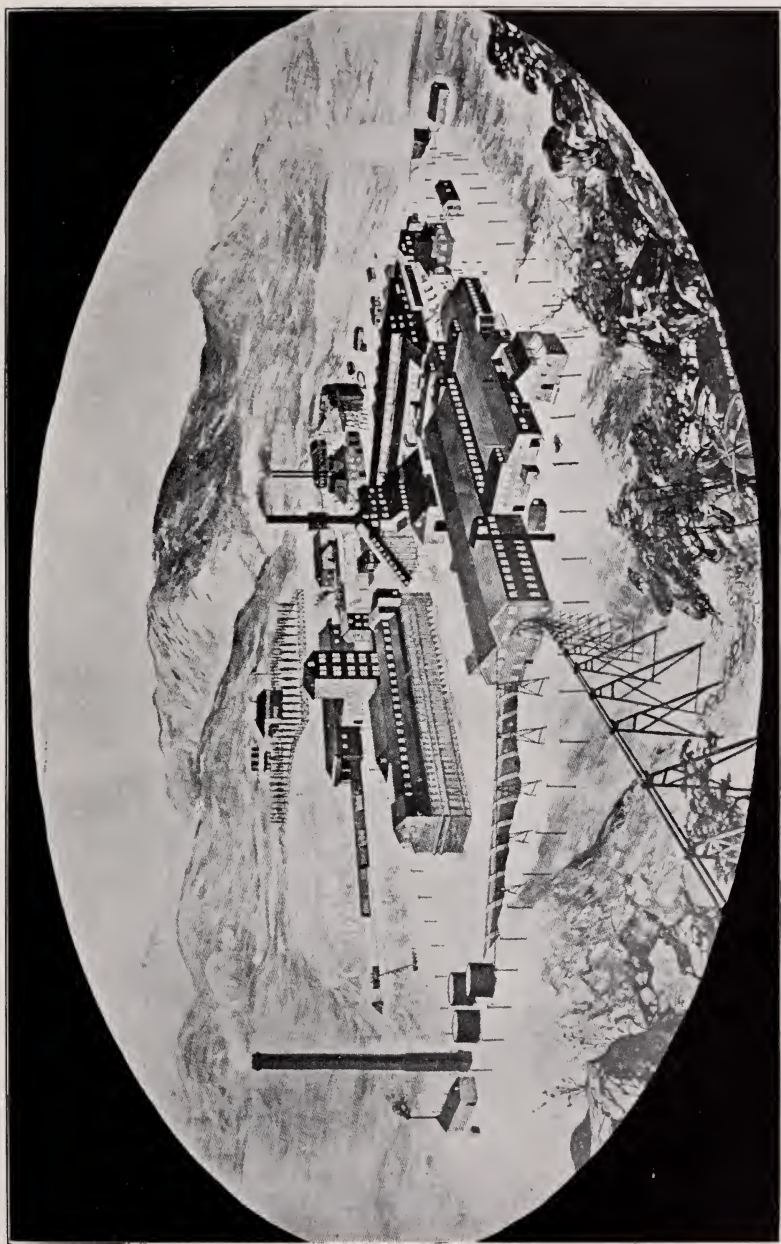
By reason of this milling enterprise, the shippers of the Cripple Creek district are enjoying the best facilities, and are accorded the lowest treatment charges on their ores, of any in the world.

The Golden Cycle Mill lays no claim to any secret process or mysterious mechanical devices, its efficiency arising from the intelligent application of well-known mechanical devices, coupled with good metallurgical talent, and enthusiastic and skilful employes.

The process employed is the one generally applied to such ores as are afforded by such districts as Cripple Creek; namely, gold ores in which the gold or silver is associated with small amounts of tellurium and iron pyrite, and not infrequently arsenopyrite. The process is one of roasting the ores, followed by straight cyanide treatment. The general method of procedure is as follows:

The ore is bought from the miner, the value of its gold content being ascertained by causing the entire lot to pass through the sampler or sampling works situated at the mill. The entire operation is automatically conducted, from the minute the lot starts through the machinery until it is delivered to the department where the final sample—or "pulp," as it is generally called—is delivered to the owner of the ore, or his agent, as the case may be.

The entire sampling operation is based on well-established laws pertaining to the art, and are capable of mathematical demonstration; and the degree of accuracy that can be attained in



Gold Ore Reduction Mill, The Golden Cycle Mining Co., Colorado City, Colo.

any properly designed and well-conducted sampling works today is truly amazing.

On the final agreement on the value of the ore between the shipper and the mill, the ore is purchased outright, the shipper receiving cash for the full amount, less a certain amount deducted as a treatment charge by the mill.

The sampling works can receive and accurately valueate from 45,000 to 50,000 tons per month.

All ores, after sampling, are conveyed, by means of belt conveyors, to one of three large bins, commonly called bedding floors. Here the different lots, as they come from the sampler, are uniformly distributed. This mixing, by automatic means, continues until a mixture or bed of some 2,500 to 3,500 tons is obtained, the size of the product varying from pieces having a maximum diameter of one and one-half inches to the very finest sand.

The object in thus mixing the ore is to obtain as nearly as possible a product uniform in gold and sulphur content. Such a mixture greatly facilitates, and tends to maintain, plant equilibrium as the treatment of the ore progresses.

The ore is removed from these bedding or mixing bins, by means of belt conveyors, to bins provided directly above the ball mills, six in number, which receive the ore through automatic feeders from the bins.

The ore is here ground the second time, until it will all pass an opening one-eighth of an inch square. The capacity of the ball mills is 1,250 tons per day.

The ore is now in the proper condition for the roasters, and is delivered from the ball mills, by means of a belt conveyor, to steel bins directly above the roasters, of which there are nine (the Edwards duplex type), each having a daily capacity of 125 tons when the sulphur content in the ore does not exceed $1\frac{3}{4}$ per cent. The ore is roasted until the sulphur content will not exceed 7-100 of 1 per cent, the tellurium being burned out early in the roasting process.

The gold is now practically all in a free state and ready for the cyanide treatment.

The fuel employed is a typical Colorado lignite, and, when properly burned, makes a most excellent fuel for ore-roasting purposes. The temperature in the furnaces ranges from 500° F., the temperature of the escaping gases, to 1,300° F., the maximum attained near the discharge end.

The ore is automatically cooled on surface coolers. The coolers are simply the furnaces extended, with the arch or top removed. The roasted ore is again conveyed, by means of belt conveyors, to bins directly above the Chilian mills, and here the cyanide treatment begins.

The ore is fed to seven six-foot Chilian mills by means of a stream of cyanide solution, and here ground, in the cyanide solution, until all passes through a screen having openings about one-fiftieth of an inch square.

The product discharged from the Chilian mills is caused to flow over blanket tables, upon which the coarse particles of gold produced in the roasting process are recovered, and subsequently reduced to amalgam form by pan amalgamation. The product discharging from the blanket tables is classified by suitable means into two products; one called the sand, or that portion which, when placed in the leaching vats, will admit of the cyanide solution being readily passed through it, thus dissolving the gold. This percolation continues for about five days, after which clear water is passed through the vat, thus removing the cyanide solution containing small amounts of gold. After the sand has thus been thoroughly washed, the residue is then discharged by means of hydraulic pressure, applied with a hose. The other portion of the product classified is called the slime, by reason of its extremely fine state of division, all of which will pass a screen having 40,000 openings to the square inch. This product, by reason of its fine state, possesses the property of holding on to, as it were, the gold in solution, or the gold that has been dissolved by the cyanide solution, and until recent years has been the means of causing terrific losses in milling, and many failures. Today the early troubles attending the treatment of this product have been overcome most efficiently, and many ores are reduced entirely to slime, as a better recovery is effected thereby. This slime-trouble, as stated above, has been completely overcome through the development of the vacuum-filter and the slime-filter processes. It is by the use of the former that all the slimes produced in the Golden Cycle Mill are successfully handled.

As is well known, the cyanide of potassium dissolves the gold. The next step in the process is to again reduce the gold to solid state, and in such form as will be readily accepted by the United States mints. This is accomplished at the Golden Cycle Mill by means of metallic zinc, in the form of shavings resembling excelsior. The zinc shavings are placed in suitable boxes—usually a large steel box divided into a number of compartments. The cyanide solution, containing the gold in solution, is caused to flow through the boxes containing the zinc, which converts the gold back to the metallic state. The gold-zinc product at certain intervals is removed, placed in suitable vessels, and the zinc dissolved and washed away. The residue, containing the gold, is thoroughly washed free of zinc sulphates and melted into bars. (Reprinted from 1911-12 Report.)

The Colburn-Ajax Mill (Victor)

By R. R. BRYAN, Mill Superintendent

The Colburn-Ajax Mill, located on Battle Mountain directly north of and overlooking the town of Victor, Colorado, treats the telluride ores from the mines and dumps of the Cripple Creek district.

The Ajax Mine, E. A. Colburn lessee, supplies 70 per cent of the ore milled. Lessees under E. A. Colburn on the Ajax property supply 20 per cent, and custom ores shipped from other parts of the district supply 10 per cent. Of the total ore milled, about 10 per cent is from old dumps of the Ajax property and throughout the district. The gold value of the ore received at the mill varies from \$50 to \$3.50 per ton, averaging \$6.70.

The sampler, operating ten hours per day and employing six men, crushes the ore to pass equivalent 6-mesh screen. The sampler's capacity when running is twenty tons per hour.

The mill, operating twenty-four hours per day and employing thirteen men, is designed as a combination concentrating and cyanide plant. The total recovery varies with the grade of ore and operating conditions. Of the total recovery, 40 per cent is by concentration and 60 per cent by cyanidation.

Grinding is done in tube-mills in cyanide solution. Classification by means of Dorr classifiers divides the whole tonnage into 25 per cent sand and 75 per cent slime. A screening analysis of the sand shows 2 per cent on a 35-mesh screen and 6.50 per cent through a 150-mesh screen. A screening analysis of the slime shows 10 per cent on a 150-mesh screen and 8 per cent through a 150-mesh and on a 200-mesh screen, or a total of 82 per cent through a 200-mesh screen. All the sand from the classifiers goes to the concentrating plant, and the slime to the cyanide plant.

The concentrating plant consists of nine Card and Flood tables and one Wilfley table. An addition to the concentrating plant is now under way to treat the slime which now goes to the cyanide plant without any concentrating treatment. The concentrates run 40 per cent iron and 12 per cent silica, and carry 4.50 ounces of gold to the ton.

The cyanide plant consists of two Dorr thickeners, five Pachuca agitators, one movable Moore filter plant, and a special zinc-dust precipitation apparatus. The agitators are equipped with electrodes, and each charge is given twenty-four hours' electrolysis

at 10 volts and 200 amperes. This electrolysis is the only special feature of the cyanide treatment. A strength of one pound cyanide per ton is maintained in all mill solutions, and a protective alkalinity of 0.5 pound of lime per ton, to attain which 9 pounds of lime are added per ton of ore at the sampler. The mill, with a capacity of 270 tons of ore per day, averages 150 tons per day actually treated. This will be increased to near capacity as soon as the betterments now under way are completed.

The zinc precipitate is acid-treated and smelted in a Donaldson tilting furnace at the refinery, giving a bullion 800 fine in gold and 180 fine in silver.

Portland Mill (Victor)

By THOMAS B. CROWE

Mill Superintendent of the Portland Gold Mining Company

The Victor plant of the Portland Gold Mining Company was built for the treatment of the ore from the Portland Mine which would not withstand the high cost of freight and treatment when shipped to the Portland plant at Colorado Springs.

The ore is brought to the mill in five-ton electric cars, and dumped into a cylindrical steel bin above the crushing plant. From this bin it is fed by an apron conveyor to a 15 x 30 Blake crusher, which reduces the ore to about three-inch size. It then passes to a thirty-six-inch, style B, Symons disc crusher, which machine reduces it to one and one-half inches; thence to a set of 20 x 48 rolls, which makes a product all of which will pass a one-inch ring. A belt conveyor takes this one-inch product to the main mill building, where, after passing through a Vezin sampler, it is distributed into four steel storage bins. These four bins discharge by plunger feeders to four six-foot Akron Chilian mills. At this point a weak cyanide solution is introduced, the mills discharging a pulp through a thirty-mesh screen, which flows and is distributed to thirty-six Wilfley tables. The concentrate from these tables is finished on six Wilfley finishing tables; the high grade, high in iron concentrate, going to the smelter; the low grade, high in silica concentrate, after sliming in a tube mill, being mixed with the regular mill slimes.

The tailing from the thirty-six Wilfleys runs to four Akins classifiers, where it is divided into sands and slimes.

The sands go to a continuous wash system (Akins classifiers), from where, after being washed free of soluble gold, they are hauled to dump.

The slimes are pumped to thickening cones, where, after thickening, they are reconcentrated on Card tables. The concentrates from the Cards join the concentrates from thirty-six Wilfleys. The tailing from the Cards runs to Dorr and Akins thickeners, the thick pulp from the same going to air agitators and thence to Portland filters, whence, after being washed free of soluble gold, it is hauled to dump.

The effluent solution from the Portland filters joins the clear overflow from the thickeners and goes to the zinc-dust precipitating plant.

The mill has a capacity of 500 tons per day, and is unique in that it uses only about 1,000,000 gallons of water per month, the tailings being hauled and stacked on the dump in a fairly dry condition. (Reprinted from 1911-12 Report Bureau of Mines.)

Mask Mill of The Eagle Mining and Milling Company (Eagle County)

By C. H. HANINGTON, Manager

Prior to the year 1907 the large bodies of low-grade zinc ores in the Iron Mask Mine at Gilman, Colo., were supposed to be too complex for successful treatment. Knowing the existence of these great bodies of zinc, the Eagle Mining and Milling Company acquired a long-time lease on the property and set to work to figure out a process of treatment. After a series of experiments, by carload lots, a process was determined upon which has proved most successful. The mill was erected in 1908 and commenced operations the following fall, and has been in continual operation since. During the year 1912 a new furnace was installed, which increased the capacity from 75 to 125 tons per twenty-four hours.

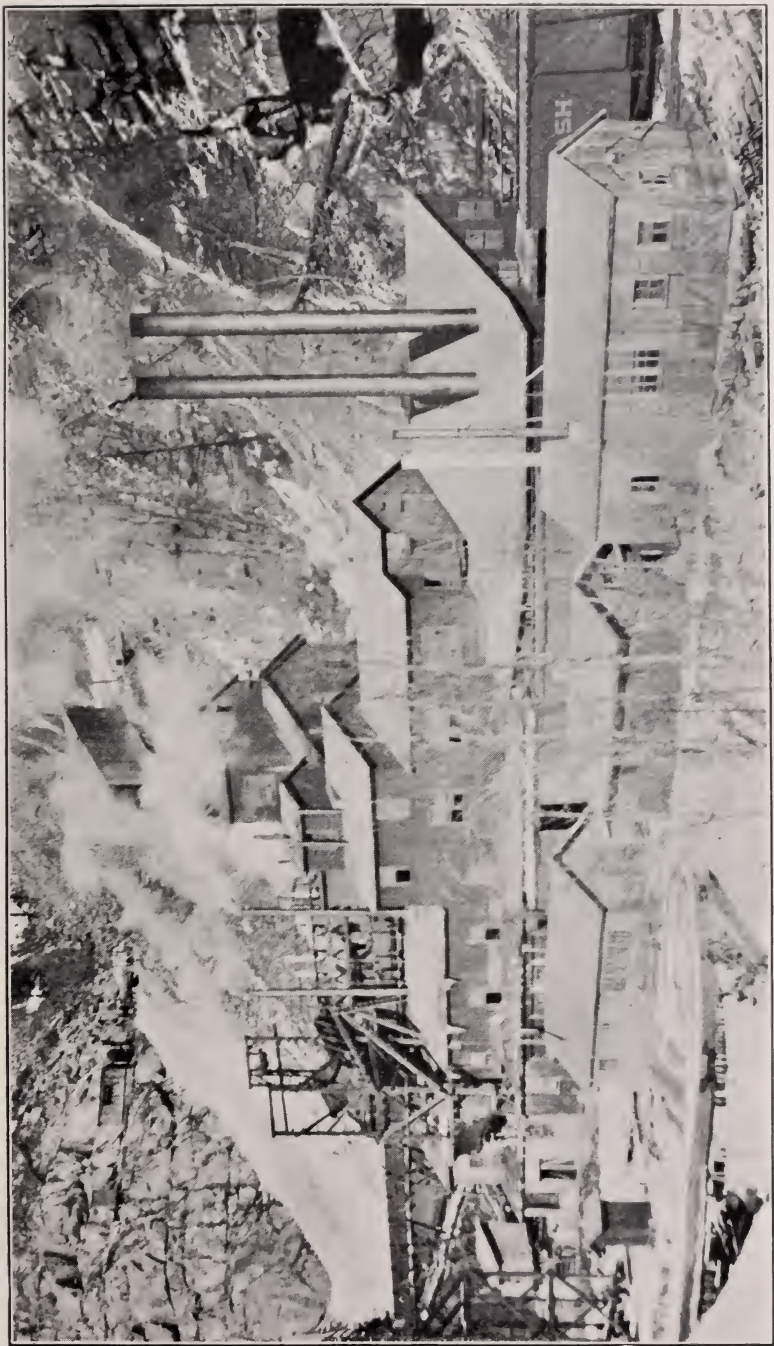
The ore assays from 15 to 17 per cent zinc, 22 to 28 per cent sulphur, with varying proportions of iron as sulphide and carbonate, manganese, lead, and some silica. The iron and zinc being more or less chemically combined presents a very difficult problem for high recovery of the zinc.

The mill is situated in the Eagle Canon, below the mine, at Belden, on the main line of the Denver & Rio Grande Railway and connected with the mine by a two-bucket, gravity, wire-rope tram.

The ore is brought from the mine and dumped into a receiving bin, from which it is fed to a 9 x 15 Blake crusher and elevated to a 300-ton bin. It is drawn from the bottom of the bin into the tramway buckets and lowered to the mill storage bin of about the same capacity.

A Challenge ore-feeder draws from the mill bin into a bucket elevator which discharges over an Edison screen, with 16-mesh and 1/8-inch mesh slotted screens. Through 16-mesh is carried direct to the bin, while on 1/8-inch mesh passes to 16" x 36" coarse rolls, and through 1/8-inch mesh to 16" x 36" fine rolls. The product from the rolls is again elevated and screened.

As there is very little difference between the specific gravity of iron and zinc sulphide, a wet separation at this stage of the process is impossible. It is possible, however, to make the separation with magnetic machines, and for this a slight roast is used to magnetize the sulphides and carbonates of iron. Three six-hearth Dewey furnaces are used for this purpose. The ore is fed into the top hearth of the furnaces and drawn from the bottom



Iron Mask Mill, Eagle Mining & Milling Co.

hearth, elevated and cooled by passing through a two-tube cooler with water sprayed on outside and inside, one cooler with 3- and 2-foot tubes doing the work very effectively. A belt conveyor carries the ore from the cooler to an elevator, which discharges into hoppers over the magnetic machines.

In passing through the magnetic machines, the magnetic particles are removed and discarded as waste, being too low-grade for shipment. The remaining products—zinc, lead, and waste—are again elevated and sized by a Bunker Hill screen, the products going to five Card tables, from which is obtained a zinc concentrate of 42 to 47 per cent zinc, which is shipped to the Zinc Smelter, and a high-grade lead concentrate, which is shipped to the Lead Smelter.

The mill is so arranged that the only handling necessary is in loading the concentrates from mill bins into railroad cars. During most of the year the entire mill is operated by a 24-inch Pelton water wheel. The water is piped 3,000 feet, with a head of 600 feet.

Stratton's Independence Mill

By PHILIP ARGALL

Until the discovery of Cripple Creek in 1891, calaverite was considered little more than a cabinet curiosity, though tellurides of gold and silver had been successfully mined in Transylvania, Hungary, and in Boulder County, Colorado, for many years. Cripple Creek was the first great deposit of gold telluride ever discovered; Kalgoorlie, West Australia, was the second; and none other has since been found.

Though gold was discovered in Kalgoorlie in 1892, it was not until four years later that tellurides were recognized, and six years before the treatment of sulpho-tellurides became a live issue in that field. In Cripple Creek the situation was entirely different, since calaverite and sylvanite were almost immediately recognized, and the treatment of the sulpho-tellurides was investigated as early as 1893. Roasting as a preparation of these ores for cyanidation was conducted as early as 1895 (no doubt the first application of roasting to cyanidation) at the works of the Metallic Extraction Company, at Florence, Colorado, where in 1896 about 3,000 tons per month of roasted ore were cyanided direct.

In experimenting with Cripple Creek ores toward the close of 1893, the writer tried removing the sulpho-tellurides by simple concentration, and in the following year published the advantages to be derived by removing the tellurides in this way before subjecting the pulp to cyanidation. The state of the arts of concentration and cyanidation at that early date did not justify the application of concentrating-cyaniding methods to the higher grades of tellurides of the early nineties, but thirteen years later, when called upon by the directors of Stratton's Independence, Limited, to advise them with regard to the treatment of \$3 to \$4 sulpho-telluride ores, these old tests formed the starting-point in the elaboration of the milling methods put into successful operation with the starting of Stratton's Independence Mill in March, 1908.

DUMP PROVES VALUABLE

In mining and shipping some \$20,000,000 worth of gold ore from the Independence Mine, about 1,000,000 tons of refuse had been sorted out and had gone to form the huge dump. It was generally assumed that this mountain of waste would average between \$1 and \$5 per ton, and it was with the idea of recovering some of the potential \$4,000,000 represented by this dump

that the directors of Stratton's Independence authorized the building of a mill. After the most careful experiments and a minute working out of details, the writer advised the directors that a mill of 10,000 tons' capacity per month could treat the dump for \$1.52 per ton, including 10 cents per ton for mining the dump, and guaranteeing an extraction of 70 per cent of the contained value. The fact that 600,000 tons of this dump since milled have shown a total value of but \$3 per ton has in no way affected the returns promised, as the fiscal year just passed showed an extraction of 80 per cent of the contained value, at a cost of \$1.3811 per ton, exclusive of amortization of mill.

Upon my advice, a mill of 5,000 tons per month was planned and erected, was tested thoroughly, and was later increased to 11,000 tons—its present capacity. The methods used are, in brief:

(a) Crushing and concentrating the ore in cyanide solution, in order that the cyanide could begin dissolving gold from the moment that the fine crushing begins.

(b) Removing the rebellious sulpho-tellurides as completely as possible, by a careful concentration process conducted alike on sand and slime.

(c) Leaching the sand in ordinary tanks, to effect a further extraction, and to wash out the remaining traces of cyanide.

(d) Treating the slime by air agitation and bromo-cyanide, or other oxidizers, as and when required. (A long and thorough series of working scale tests soon convinced us that bromo-cyanide was the best solvent in our case, though somewhat erratic in its action, and always requiring the most careful chemical application.)

The application of these methods, as shown in the present mill operations, is as follows:

Dump Mining

The dump is mined by means of an electric shovel, equipped with a dipper of one cubic yard capacity, which mines the ore and loads it into cars of four tons capacity. These cars are hauled up an incline from the dump to the breaker plant by means of an electric hoist and the cars automatically discharging onto the breaker. The cost of operating this department for the last fiscal year was \$0.111 per ton.

Dump Breaker Plant

The ore discharges directly upon a Gates gyratory breaker, size 7½ D, which reduces it to pass a four-inch ring and delivers the broken product to a grizzly. Here the fines are removed, while the coarse passes onto a picking belt, where worthless red granite and old steel of various sorts—such as drills, car wheels, hammer heads, and track spikes—are removed, and the selected material passes on to a Gates gyratory breaker, size 5K, where it

is broken to pass a one-and-one-half-inch ring. The discharge from the small breaker, together with the fines from the grizzly, is then sent to the crude-ore storage bin.

From the crude-ore bin, as needed, ore is drawn through two sets of 16" x 36" rolls, which reduce the ore to the approximately three-eighths inch, and it is then delivered to the Chilian mill bins.

Mine Breaker Plant

In addition to the above, another breaker is installed at the shaft, to take care of the low-grade ore that is won in the course of development work, or that may be sorted out from the ore-house waste. This plant is equipped with 5K Gates breaker, 16" x 36" rolls, and screens, the finished product being sent direct to the Chilian mill bins, averaging three-eighths inch in size.

Fine Crushing

This plant consists of four Akron Chilian mills of six feet diameter, three of which easily give the required 11,000 tons per month, while the fourth is held in reserve until needed to replace one of the others. These mills, with 0.046 inch screen aperture at thirty-three revolutions per minute, give a fairly steady output of 125 tons each in twenty-four hours. Rolled steel tires and dies are used, of the Midvale brand, and the average consumption of steel figures 0.62 pound per ton of ore crushed. The power consumed per mill varies from fifty to fifty-five horsepower, depending upon the feed and the condition of the mill.

Tellurides are friable, and while the fine is richer than the coarse, in most cases, yet the ores of Cripple Creek afford the greatest contrast in this respect. From the lumps that will pass through a two-inch grizzly to the dust caught in the rafters of the mill, the finer pieces and particles are invariably the richer. Advantage was taken of this fact, and extensive experiments conducted to determine the best method of crushing and the most economical size of reduction.

The ore of Stratton's Independence appears at first glance to consist of a rather sparse scattering of sulphides in phonolite and phonolitic breccia. On closer examination, it is found that the gold occurs chiefly as films along fracture planes, or in cavities, or in small veinlets. The sulphide in the body of the rock is invariably low-grade, and occasionally worthless. To crush the rock fine enough to liberate all the sulphides was out of the question on account of the cost, the dressing loss in concentrating slime, and the low-grade product obtained from the concentrators. Experiments were made with rolls, stamps, pans, and Chilian mills; the latter giving the best results. Then followed experiments with size-crushing on a full working scale, made through screens varying from 0.02 to 0.10 inch aperture. The best average results were obtained around 0.046 screen aperture, which, on \$3.00 ore, gives us a sand tailing averaging, after concentration.

about 80 cents per ton, and a slime running from \$1.50 to \$2 per ton after concentration; both products being subjected to further cyanide treatment.

The guide chosen, after months of experimenting, is not to allow the sand tailing from the table to exceed \$1 per ton. When this limit is approached, a finer screen is used on the mills. Comparatively coarse crushing, and eliminating 40 to 50 per cent of the ore as sand, with as poor a tailing as we can obtain from the slime, is one of the nice points in our practice not generally seen, or, at least, understood by either the casual observer or the critic. Here the physical character of the ore is utilized to obtain:

(1) A coarse sand, from which a high-grade concentrate and an almost worthless tailing are obtained in one operation.

(2) An enriched slime, from which a high-grade concentrate can also be obtained, leaving but 50 to 60 per cent of the original ore for special treatment, such as air agitation, oxidizing chemicals, and filtration.

Concentrating

The discharge from the Chilian mills is run to two Ovoca classifiers, where the sand is separated from the slime. The sand passes to a distributor, which feeds twenty Card concentrating tables, or any less number, as the distributor is automatic and so arranged that any table being plugged off, the pulp immediately arranges itself to suit the smaller number of tables. The slime passes to thickeners, the thickened slime from these to a similar distributor, which supplies the Deister slime tables and the four vanners, or any less number. From Card and Deister tables alike there are obtained a four-to-five ounce first-grade concentrate, running 8 to 10 per cent silica and 35 to 43 per cent iron, and a middling product, which is returned to a 14' x 5' tube mill, ground and reconcentrated, giving a two-ounce product, with 14 per cent silica and 30 per cent iron. The Card table sand tailing usually assays .04 ounce, while the Deister and vanner slime tailing averages .10 ounce. Both sand and slime tailing is pumped from the concentrator building to the cyanide building by four-inch centrifugal pumps, while the concentrate is collected, drained, and shipped to the smelters. The cost of fine crushing and concentrating for the year was:

133,875 tons; working cost, \$67,478.15, or \$0.504038 per ton.

Cyanidation

After concentration, the various tailing products are pumped to the cyanide plant and again passed through Ovoca classifiers, to be separated into clean sand and slime. These classifiers give a sand practically free from slime and carrying from 15 to 25 per cent moisture, as desired. They consequently perform a double service—slime separation and sand de-watering. Bromo Cyanogen will break up gold telluride provided the ore is reduced to pass

a screen of 200 mesh to the lineal inch, hence the importance of having the slime practically free from sand particles. How well this is accomplished by modern classifiers is seen in the following table, giving the results obtained by the "OVOCA" Classifier in the Independence Mill for 12 months ending September, 1913. To the clean sand at the head of the classifiers is added as much barren solution as will pass through the tanks during filling, the mixture of sand and barren solution being conveyed to the desired tank by means of a reciprocating conveyor. Leaching thus continues throughout the filling process, and is continued until the value is extracted, when, after water washes, the sand is sluiced to the tailing ponds.

Ovoca Classifier		X30	X50	X100	X150	X200	-200	Tons
Oct. 1912	Sand	.....7.15	21.8	40.1	12.3	10.65	8.0	5,623
Oct. 1912	Slime	.....	....	....	1.0	2.50	96.5	5,271
Nov. 1912	Sand	.....6.4	20.2	41.0	12.6	9.6	10.2	5,511
Nov. 1912	Slime	.....	....	....	1.0	2.0	97.0	4,785
Dec. 1912	Sand	.....7.6	22.08	37.32	13.8	11.48	7.72	5,558
Dec. 1912	Slime	.....	....	....	1.0	3.0	96.0	5,236
Jan. 1913	Sand	.....5.45	19.4	38.59	14.65	14.36	8.56	5,532
Jan. 1913	Slime	.....	....	....	1.00	2.00	97.00	5,005
Feb. 1913	Sand	.....6.85	21.85	37.90	12.65	13.75	7.00	4,994
Feb. 1913	Slime	.....	....	....	1.00	2.00	97.00	5,116
Mch. 1913	Sand	.....7.28	21.24	38.92	13.28	13.36	5.92	5,540
Mch. 1913	Slime	.....	....	....	1.00	2.00	97.00	5,629
Apr. 1913	Sand	.....7.60	20.60	40.60	12.10	13.95	5.15	5,089
Apr. 1913	Slime	.....	....	....	1.00	2.00	97.00	4,977
May 1913	Sand	.....7.65	19.30	39.30	12.80	14.45	6.50	5,960
May 1913	Slime	.....	....	....	....	2.00	98.00	5,576
June 1913	Sand	.....9.00	20.61	38.44	13.04	12.36	6.52	5,586
June 1913	Slime	.....	....	....	....	2.00	98.00	5,120
July 1913	Sand	.....7.0	17.45	40.70	14.4	13.0	7.95	5,388
July 1913	Slime	.....	....	....	1.0	2.0	97.00	5,681
Aug. 1913	Sand	.....8.8	20.6	41.55	12.65	10.85	5.55	5,601
Aug. 1913	Slime	.....	....	....	....	2.00	98.00	5,428
Sept. 1913	Sand	.....6.80	18.48	41.40	15.40	10.00	7.92	4,892
Sept. 1913	Slime	.....	....	....	1.00	2.00	97.00	6,281
Total tons								129,382

Average results on 129,382 tons treated of 2.87% plus 200 mesh in the slime and 7.25% minus 200 mesh in the sands, the minus 200 mesh in sands is not slime but an extremely fine sand that leaches so readily that the tanks are filled by sluicing the sand into them and perfect leaching obtained without mechanical distribution of any sort; the sluicing water leaches through the sands as fast as it enters the tanks, thus materially shortening the extraction period. No form of mechanical screen could give such results in quantity; that above products can be obtained, without screens is little less than marvelous.

The slime is collected in cone-bottomed steel collecting tanks, and charges of thickened slime are drawn from these every twelve hours to a similar-shaped treatment tank, fitted with a pneumatic agitator. The air lift tube ends about ten feet below the surface of the charge, where a small reverse cone disperses the ascending stream. In this way the upper portion of the charge is kept in brisk agitation by a surprisingly small amount of air. Sand, if present, sinks and is deflected toward the side of the vat by the lower cone. Rapidly settling to the suction of the lift, it passes up again, and in this way is kept in active agitation. In the pneumatic type of agitator, where the air lift discharges above the surface of the charge, the compressed air escapes into the atmosphere before it is fully expanded; while in the method here described the expanding air is dispersed and keeps the whole charge, above the reverse cone, in brisk agitation, instead of that small portion of the charge within the central tube, as in the old style of pneumatic agitator. The slime is worked in charges of about eighty tons, agitated in cyanide solution of varying strength, and, as required, given a final treatment with bromo-cyanogen.

The solutions are precipitated on zinc shaving, the dried precipitate being ground to impalpable powder in a special tube mill, and sold to the refineries.

The clear solution overflowing from the slime settlers in this department returns to the Chilian mills, flows over the tables, and returns to this department with more slime, thus forming a closed circuit. Sufficient solution is withdrawn and precipitated from this circulation each day to keep the gold content down to less than a dollar per ton.

Conclusion

The points to be especially noted in this brief description are the following:

- (a) This is the first mill anywhere in the world to successfully treat \$3 sulpho-telluride ores.
- (b) Concentration in cyanide solution.
- (c) The closed circuit; i. e., the solution is constantly in circulation from the Chilian mills, over the tables, through the tanks, over the zinc boxes, and back to the Chilian mills.
- (d) The use of bromo-cyanogen on the most rebellious ores.

MILLING COSTS

Per Ton

Coarse crushing and sorting.....	\$ 20,922.94 or \$0.156288
Fine crushing, concentrating and treating concentrate.....	67,478.15 or 0.504038
Cyaniding and special chemicals.....	62,550.01 or 0.467226
Miscellaneous expense	19,081.60 or 0.142532

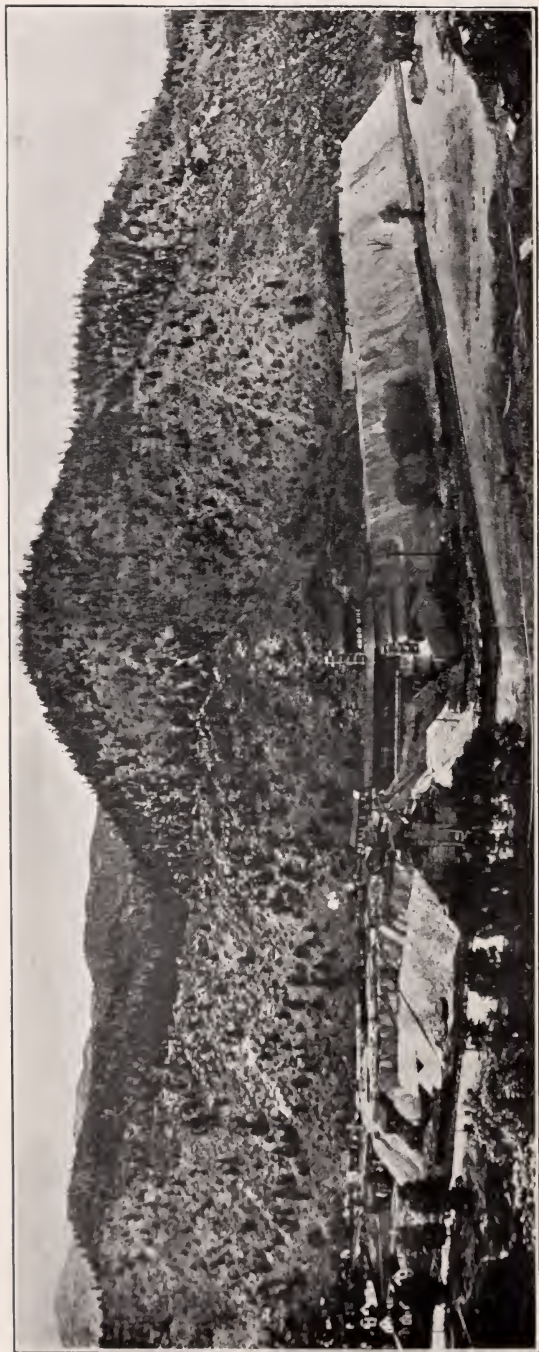
Working cost, 133,875 tons.....	\$170,032.70 or \$1.270084
Mining dump ore	14,865.61 or 0.111041

Total working cost\$184,898.31 or \$1.381125

Exclusive of amortization of milling plant.

Delayed for a time through financial reasons, the mill started work in April, 1909, and has been in continuous and successful operation from the first, and is earning more than 15 per cent per annum on the capital of the company. The costs of the process undoubtedly set a record for the treatment of low-grade rebellious ores, especially for those of the Cripple Creek district, where the lowest open rate when the erection of Stratton's Independence Mill was begun amounted to \$5.75 per ton, since reduced to \$4.00 per ton.

There are no secrets, the methods being simply a combination of already well-known processes adapted to meet the conditions, and the methods so worked out in this mill have since become the standard method in use in the successful sulpho-telluride mills of the district.



Showing Portal of Argo Tunnel, Immense Dump, and Argo Mill, Idaho Springs, Colo.

The Argo Mining, Drainage, Transportation and Tunnel Company Mill

By OTT F. HEIZER, Mill Manager

The Argo Mill was built by the Argo Reduction and Ore Purchasing Company, of Idaho Springs, as a custom plant to purchase and treat the ores from the Argo, or Newhouse, Tunnel. It is conveniently located about 500 feet east of portal of the tunnel, the battery floor being on the same level. Construction was begun in June, 1912, and the mill started operations in April, 1913. Except for a period of about six weeks in November and December, 1913, during which time a change in management was made and the flow sheet of the mill revised, it has operated continuously to this date.

The mill constitutes a distinct advance in the metallurgy of the ores of Clear Creek and Gilpin Counties. The old, slow, high-drop, light-weight stamps have been succeeded by rapid, short-drop, heavy stamps; amalgamation, both inside and outside, has been dispensed with, and modern riffled tables have taken the place of the bumping-table. Crushing is done in cyanide solution instead of water, and the slimes, once a fruitful source of mill loss, have been forced to yield practically all their values.

Ore from the tunnel in three-ton solid box cars is weighed and delivered by means of a traveling revolving tippie to the receiving bins, twenty-two in number, each having a capacity of seventy tons. Ores from outside sources are transferred from the railroad cars to tunnel cars, and hauled up an incline to the scales. Each shipper is allotted a bin, which, when filled, is drawn onto a pan conveyor, which delivers to the sampling plant of 300 tons' daily capacity. The ore passes through a series of crushers and rolls, the final sample emerging on the lower floor being 10 per cent of the original lot and crushed to pass a $\frac{1}{4}$ -inch screen. This sample is further reduced, pulverized, and divided between shipper and mill, and settlement is made on its average assay.

From the sampler the ore is lifted by a combination of two bucket elevators and two belt conveyors, and discharged into the battery bin of 1,500 tons' capacity; thence through four suspended-type Challenge ore-feeders to twenty 1,050-pound stamps, dropping 110 times a minute through 6 inches. Each ten stamps is driven by a 25-H.P., back-gearred motor belted direct to the bull wheel. The ore bin is divided into two compartments, into

one of which is run the ore of such character as yields barren sands after concentration. This is stamped through 16-mesh screens. The other compartment is used for the highly siliceous ores, which must be slimed to free all the metallics from the quartz. Because of the limited tube-mill capacity, a 20-mesh screen is here used to make as much slime as possible in the batteries.

The ore is stamped in a solution containing one pound of cyanide per ton. The discharge from the 16-mesh screens is passed through a Duplex Dorr classifier, the sands going to a distributor which serves six Card tables, and the slimes to a 22' x 14' thickener preparatory to agitation. The Card tables make four products: lead concentrates, iron concentrates, middlings, and sands. The lead and iron go to storage bins on the lower floor after being dewatered to 12 per cent moisture in quarter-size Dorr classifiers. The middlings are reconcentrated, and their sands fed to the tube-mill. The sands from the upper tables pass through a three-unit dewatering classifier, where they are washed with barren solution and then water, and discharged to waste at about 25 per cent moisture. The discharge from the 20-mesh screens is by-passed over the classifier to a spitzkasten, where the coarser portion is settled out and concentrated, the sands going to the tube-mill. None of the product from the 20-mesh screens is discharged as sands. The spitzkasten overflow joins the Dorr classifier overflow in the 22' x 14' thickener.

The tube mill is 4 feet in diameter and 10 feet long, and operates in closed circuit with a quarter-size classifier by means of a 4-foot scoop feed. The pebbles are fed to the mill by a reverse spiral in the discharge end. The overflow from the tube-mill classifier, after being thickened to about 65 per cent moisture, goes to the 20' x 12' Dorr agitator, where it meets the underflow from the first thickener and receives about twenty-four hours' treatment. The agitator charge is kept at a temperature of about 62 degrees, about 65 per cent moisture, one and one-half pounds of cyanide and one pound of lime per ton. The agitator discharges by means of a centrifugal pump to three slime-tables, which remove the sulphide freed by the tube-mill. The pulp then goes through three 20' x 12' thickeners in series, where by successive dilutions with barren solution its value is reduced to about 15 cents per ton in dissolved values. The underflow from the third thickener is pumped to a 7½' x 12' Portland filter, where it is pressed to recover the dissolved gold values and cyanide, and discharged to waste. The overflow from the first thickener is forced to rise through an excelsior filled tank; then drawn through a sand clarifier tank to the zinc boxes for precipitation. The precipitate, after acid treatment, is melted into bars in an oil-fired tilting furnace, and shipped to the mint. The average fineness is about 187 gold and 500 silver; the base being practically all copper. The concentrates are shipped to the Globe Plant of the American Smelting and Refining Company.

The mill and sampler are housed in a steel-frame building with concrete retaining walls and floors. The tanks are of steel. The mill is handled by a solution man and a battery-man on each eight-hour shift. Repairs are taken care of on the day shift by a mechanic and oiler. The plant is motor-driven by ten motors of from 5 to 50 horse-power. The building and solutions are heated by a 25-H.P. boiler carrying 20 pounds of steam.

The capacity of the plant is 120 tons a day, but it receives, on an average, 60 tons a day. For this reason the costs are unduly high, as 3,500 tons per month could be treated with a slightly higher power bill and proportionate increase in cost of supplies, the labor remaining the same.

As the ore for the mill is secured from ten or twelve different mines, none of which ship any given proportion of the daily tonnage, the character of the mill feed varies greatly from day to day. The daily average value of the ore milled varies from \$3 to \$15, which complicates the mill control. The physical character of the ore varies as radically as the values, and under present conditions any given lot of ore is through the mill before any analytical knowledge of it is available. This greatly increases the difficulty of obtaining a satisfactory extraction from these naturally complex and refractory ores. It is daily found that necessary changes in adjustments all through the plant are no sooner completed than new conditions have arisen, through a radical change in mill feed, that necessitate a different adjustment.

The following table records the average performance of the mill from January 1 to August 31, 1914:

Average number tons ore milled per month.....	1,837.7
Average pounds cyanide used per ton of ore.....	2.02
Average pounds lime used per ton of ore.....	4.31
Average pounds zinc used per ton of ore.....	.44
Average value heads per ton.....	\$10.52
Average per cent extracted.....	89.54%

Per cent saved, 1914:

January	84.5
February	86.3
March	94.4
April	83.5
May	89.5
June	90.6
July	94.2
August	92.9

SCHEDULE D**Purchase of Ores F. O. B. Argo Mill**

Subject to change without notice

GOLD:	Pay \$19.00 per Oz., if 0.05 to 1.50 ounces per ton. Pay \$19.50 per Oz., if over 1.50 ounces per ton.
SILVER:	Pay New York quotation, date of assay, for 60% of the silver assay, if one ounce or over per ton.
LEAD:	Deduct two units from the fire assay and pay 25 cents per unit for the balance.
COPPER:	Deduct 1.5 per cent from the wet assay and pay \$1.00 per unit for the balance.
ZINC:	No pay. No penalty.
SAMPLING:	No charge.

TREATMENT CHARGES

	Ton
Up to \$ 5.00 gross value per ton.....	\$ 3.50
Over 5.00 to \$ 6.00 gross value per ton.....	3.75
Over 6.00 to 7.00 gross value per ton.....	4.00
Over 7.00 to 8.00 gross value per ton.....	4.25
Over 8.00 to 9.00 gross value per ton.....	4.50
Over 9.00 to 10.00 gross value per ton.....	4.75
Over 10.00 to 11.00 gross value per ton.....	5.00
Over 11.00 to 14.00 gross value per ton.....	5.25
Over 14.00 to 20.00 gross value per ton.....	5.50
Over 20.00 to 25.00 gross value per ton.....	6.25
Over 25.00 to 30.00 gross value per ton.....	7.50
Over 30.00 to 35.00 gross value per ton.....	8.00
Over 35.00 to 40.00 gross value per ton.....	9.00
Over 40.00 to 45.00 gross value per ton.....	9.50
Over 45.00 to 50.00 gross value per ton.....	10.00
Over 50.00 to 75.00 gross value per ton.....	11.00
Over 75.00 gross value per ton.....	12.00

Milling at the Barstow Mine (Ouray)

By C. R. WILFLEY, Manager

Milling at the Barstow developed nothing exceptional during 1913-14. The principal features were the treatment of gold ore without the amalgamation formerly used, and the production of zinc-iron for electrostatic separation at the plant of the San Juan Metals Company, Ouray, using Huff machines.

The equipment was originally forty stamps, plates, and two sets of Wilfley tables, with no classification. Small ore reserves and heavy winter conditions have not allowed steady operation nor extensive remodeling. The main objects have been reasonably well attained by using half the crushing machinery and all the tables.

The ore is a clean quartz, carrying mixed sulphides of lead, copper, iron, and zinc, common in the San Juan. It is found in two grades or classes, the more important being the gold ore, the second grade being a heavier sulphide low in gold and silver, as well as copper, but heavy in lead, iron, and zinc.

The gold ore has a clean quartz gangue. The gold assay varies a good deal, while the silver is rather steady, running 5 to 10 ounces. The gold is not often visible, but milling liberates a large percentage, and the rest follows the sulphides in the concentrates. Probably most of the gold is deposited in and with the sulphides. The copper and iron, as well as the lead, carry more of the gold than the zinc—an advantage in the electrostatic work. The concentrate amounts to about one-seventh of the weight of the crude ore, and carries 80 to 85 per cent of the gold in the original ore. Much of the gold is extremely fine particles, and it seems well established that the loss is in included particles which would have to be liberated by fine crushing.

The details of milling have varied, but the handling of the gold ore has followed one general line—the saving of the gold in two classes of concentrate, with a separation of zinc when there is enough to cause penalty or to make a paying product. After crushing in stamps through about .020 inch, the ore is fed to the first tables, where most of the lead is taken out, with most of the gold and silver. This lead concentrate includes much of the iron and enough copper to pay, but with little zinc. The lead in the ore is often so low that it has not seemed worth while to try to take out a high-grade lead concentrate.

From the first tables coarse sand is sent to waste, and middling and fine tailing, as well as slime, sent to the second tables. "Middling" is herein used to designate the mixture of free mineral and quartz grains rather than true included particles. Under ordinary conditions, these second tables cut out all the concentrate possible, with sand tailing to waste and slime to slime-tables. A middling is then sent through classifiers to third tables, where the final concentrate is taken out. The second- and third-table concentrates are a copper-iron product, with lead less than 5 per cent, and copper 2 or 3.

When the zinc is heavy enough to interfere, which is not usual, the second set of tables is simply tilted so as to take out a copper-iron under penalty in zinc. The rest, with the middling, goes to the third tables, where copper-iron-zinc is cleaned up enough to make a product for separation. When the zinc is heavy or separates well, it is sometimes possible to cut out on the third tables a small copper-iron streak and leave an enriched iron-zinc concentrate. I believe this is aided by the classification.

This classification I believe to be important; primary classification, on this ore at least, has not seemed to me particularly useful, but the natural arrangement of minerals in the second-table middling makes a good product for hydraulic classification followed by tables. In this middling, fine zinc and iron have been caught under the ore bed along the lowest riffles and brought out into the concentrates, low down; silica in fine particles also mixes in, this way, with coarser particles; finally, there is more or less of a mixture of gangue and mineral, but without the proportions and character found in the crude ore. When sent through hydraulic classification in two or three sizes, the following tables show a clean line of separation, and sometimes it is possible to take out iron-copper, as mentioned, since the various particles are arranged more according to gravity by the classifier and much of the interference is broken up.

It might be contended that hydraulic classification at the head of the mill would accomplish the same result. This was tried in this mill, but was discarded as being no improvement, while being a source of more or less trouble. A simple launder or trough classifier, drawing off through holes in the bottom, was substituted. Primary classification would have to be extensive; it might be best, if ideal, but economically we have found it best to use a sort of roughing system and practice refinements on the product demanding the only close separation of minerals from each other. Screening, if thorough, would probably be better than classification on this middling; however, the middling is quite different from crude ore, besides being free from slime, and is a good feed for the classifier.

The slime is passed over the first two sets of tables, thus receiving two treatments before reaching the slime-tables, of which there are two Wildey multiple-deck machines. Assays seem

to show that a considerable amount of fine mineral is settled through the ore bed and brought out into the fan of coarser concentrates, thus relieving the slime-tables.

The handling of the low-grade, heavy ore is similar to that of the gold ore. There is enough lead to take out a 55 to 60 per cent product on the first tables, with most of the iron sent to the second tables, which make a low-grade iron, carrying little copper. An appreciable amount of lead is caught here when the mill feed is high in lead. The third tables make a 30 to 35 per cent zinc, carrying some fine lead and a little copper.

Electrostatic separation of the zinc-iron makes good products and is economically an advantage. At present it is not of great importance, because of the small amount of zinc-iron produced. The production of low-grade ore being on the increase, the process bids fair to be of more importance. The saving of copper and lead is an interesting feature, since both are thrown into the separated iron in much larger proportion than into the zinc, bringing them into the "pay" sometimes when they are too low in the original.

The slime-tables make a satisfactory addition. The slime is not rich and does not cause large loss; hence the slime concentrate is not a heavy factor.

The tables show the classes of product handled, being in most cases average figures.

Ordinary gold ore produces:

Conc.	% Wgt. of		Assaying					
	Crude		Dry					
	Ore	Gold	Silver	Lead	Copper	Iron	Silica	Zinc
Lead	9.6	4.97	37.0	11.53	0.5	34.0	2.0	6.0
Copper-iron	4.5	.53	10.5	1.0	1.7	27.5	7.4	10.0

Rich gold ore makes similar products, with gold up to 17 ounces, and silver up to 52 ounces per ton.

Low-grade ore produces:

Conc.	% Wgt. of		Assaying					
	Crude		Dry					
	Ore	Gold	Silver	Lead	Copper	Iron	Silica	Zinc
Lead	19.3	.37	22.1	54.0	0.5	9.40	1.65	6.0
Copper-iron	7.5	.21	9.6	3.0	1.0	34.00	4.50	10.0
Iron-zinc	8.0	.07	13.1	8.9	0.2	11.20	13.80	30.61

This last, iron-zinc, separates electrostatically into:

Iron	2.3	.13	19.3	16.0	1.5	25.5	6.00	9.5
Zinc	3.1	.015	6.1	2.5	...	4.1	13.90	48.5

The advantage of electrostatic separation in this case is obvious. The iron-zinc is practically worthless before separation, but is converted into two valuable products by the process.

The Lombard Mill

By HENRY I. SEEMANN
President and General Manager

This mill belongs to the Continental Mines, Power and Reduction Company, with headquarters in Denver.

The ore mined for the purpose of reduction comes principally from the Lombard Mine, which, with other properties, is located in the northwestern part of Clear Creek County. As early as thirty years ago a small mill consisting of five slow-drop stamps, and one concentrating-table, were in use on the Lombard ore. The prime object was amalgamation, and as the ore was over 90 per cent free milling, very little consideration was paid to concentration, although the concentrates ran as high as \$50 per ton. After this company purchased the Lombard properties, and the ore was tested for several months in the old mill, a new mill was erected, at a cost of \$25,000, 750 feet below the old one. The success of the operation was very gratifying, and in consequence the mill was again enlarged, until it now contains twenty stamps of 1,000 pounds, dropping at the rate of 105 per minute, with a capacity of 100 tons per day on medium-hard ore. Although the ore has changed considerably on account of the depth gained in the mine (900 feet), the amalgamation process is still one of the principal treatments of the ore. After the free gold is extracted, the residue is concentrated, producing iron, zinc, and lead concentrates. The process is about as follows:

The ore is broken in the mine and brought out in tram cars through the Lombard Tunnel No. 4, and dumped over a grizzly having a space of one inch between the bars. All the fine stuff falls into an elevator having an endless belt with steel buckets, and it is automatically transported to the highest point of the mill and dropped into an ore bin of 300 tons' capacity. The coarse rock falls before a crusher, which is also reduced to one-inch size or less. This is also elevated to the ore bin. After this the mill is automatic and requires only two men to run it. In front of this bin are four automatic feeders, each feeding five stamps. The amalgamation begins in the battery, as the latter contains a copper plate on the rear end. As the 30- to 40-mesh crushed pulp comes out, it first passes off the lip plate, 12 inches wide, and then drops from 3 to 4 inches to the first plate, 4 feet long. Then comes another plate, 5 feet long, but between them is a drop of about $\frac{1}{2}$ inch. The last copper plate is 6 feet long where the amalgamation is finished. Each battery has 16 feet of copper plates, and we find them all serviceable. The company estimates that the savings amount to from 50 to 70 per cent

of the entire values in the ore on the copper plates.* The balance of the pulp is subjected to a crude way of sizing—which, by the way, will be very much improved next spring.

The concentration first takes place over three Wilfley tables, and afterwards is passed down to three Card tables of the latest pattern. While the saving is fairly good, it is not entirely satisfactory, and the company expects to make exhaustive experiments next spring. Several plans are now being considered, such as re-grinding, with a further amalgamation and concentration, on slime-tables. The cyanide process is also being considered; but all this will have to be experimented with on a large scale, and whatever will be done will be only after a thorough and scientific experimentation. A further enlargement of the present Lombard Mill is also being considered by the company, but this will not be done until the development work now on the way is fully finished, and the additional ore bodies are opened up to warrant this expense.

Mount Champion Mill (Leadville)

By J. A. BECKER, Mill Superintendent

The Mount Champion Mill, situated sixteen miles from Leadville, has an aerial tram one and one-fourth miles to the mine. The ore is a hard quartz and iron sulphide, the values being gold and silver, with small values in copper and lead. The high-grade ore is shipped directly to the smelter at Leadville. The mill ore is crushed by a No. 4 Samson crusher to about 1½-inch size. An 18-inch Symons disc crusher reduces this material to about ½-inch size.

At present this product from the Symons crusher is sized, the coarser material going to the Hardinge mill, while the fines go to the tube mill. Silver-plated copper plates are used in amalgamating, followed by blanket tables to catch the coarser gold particles, which cannot be saved by amalgamation.

A Richards hydraulic, air-pulsator classifier classifies the pulp for concentration, the coarse material going back to the tube-mill for re-grinding.

Wilfley and Deister sand-tables are used, and the No. 3 improved Deister slimer. The concentrates are shipped to the Arkansas Valley smelter at Leadville.

The tube mill is a 5' x 14' tire type. Both silex and El Oro lining have been used in lining it, the latter being now used, as there is not much delay in installation.

The Hardinge mill has an 8-foot diameter, the size being especially adapted for coarse feeds. Pebble lining (pebbles cemented) has not proven so satisfactory as the plate lining.

The mill is run by electrical power, and has a capacity of approximately 100 tons.

The Carter Mining Company Mill (Gunnison County)

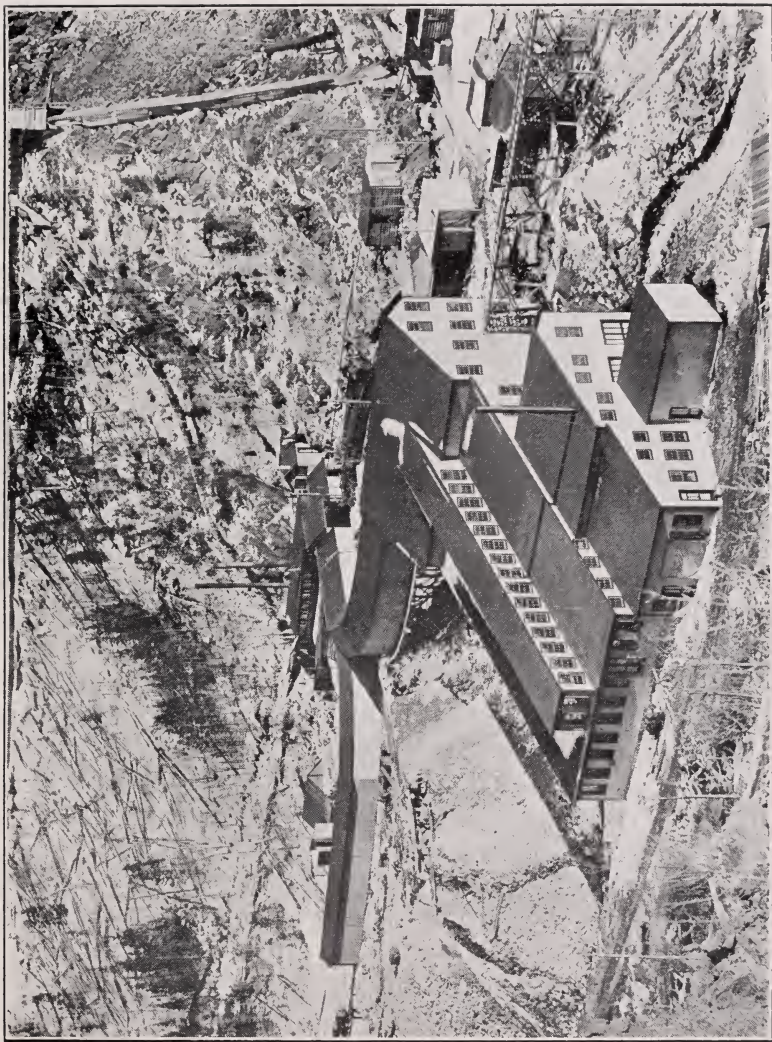
By CARROLL M. CARTER, Manager

The Carter Mill has a steam-heated building large enough for thirty stamps and twelve concentrating-tables. At present the machinery in the mill consists of one large jaw crusher, capable of crushing in eight hours enough ore for thirty stamps for twenty-four hours' run; twenty 1,000-pound stamps with automatic suspended feeders; four amalgamating-plates, 4' x 12'; a classifier, and five Wilfley tables.

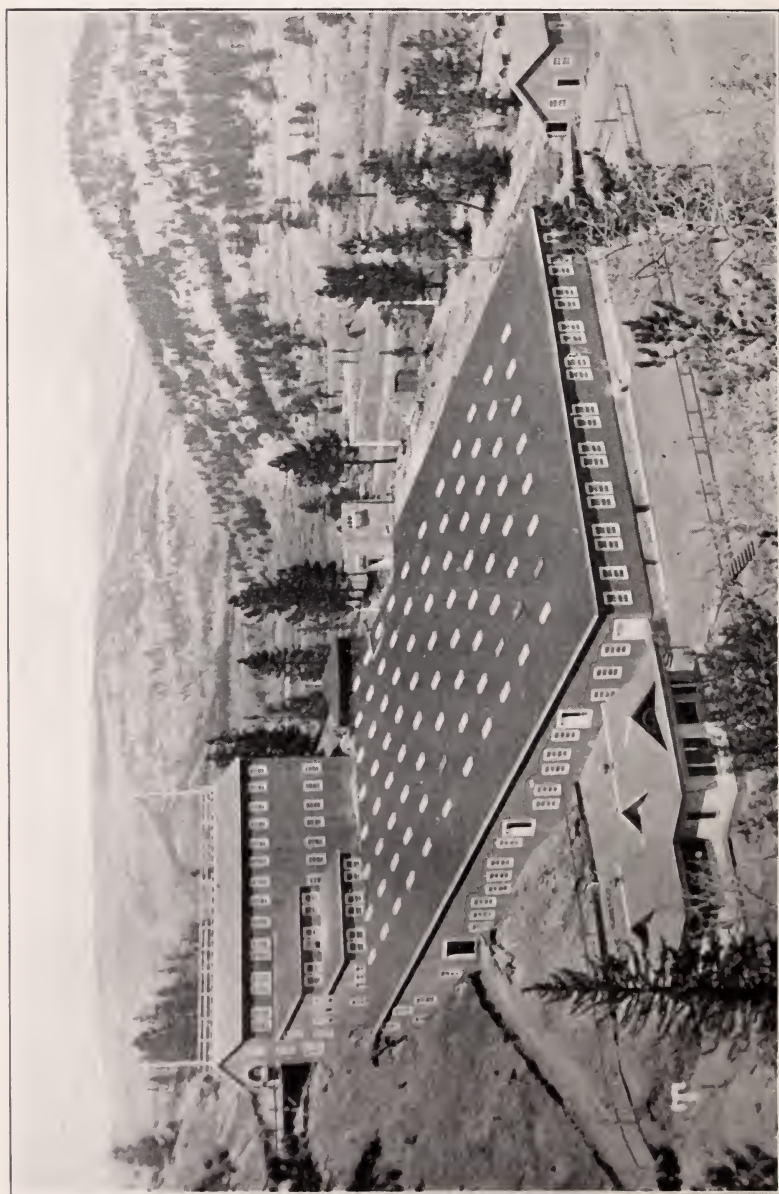
The crusher is just below the ore bin. From this bin the ore goes through the crusher onto a conveyor belt, which distributes it evenly into a 100-ton bin, from which it goes to the feeders. The pulp from the amalgamating-tables or plates is raised to the classifier in a pulp pump, and then goes through launders to the Wilfleys. The middlings from these tables are raised by another pulp pump, and then go over a middlings table.

All the machinery, except the crusher, is on one floor, which greatly lightens the work of the mill-men and increases the saving by reason of increased attention to stamps, plates, and tables. In mills that require constant climbing of stairs, poor work is frequently done by reason of the weariness of the mill-men.

The mill is driven by two Pelton wheels—one wheel for the crusher and stamps, and the other for the Wilfleys and lighting dynamo.



Mill of Carter Mining Co., Ohio City, Colo.



Primos Tungsten Mill, Lakewood, Colo.

The Primos Mining and Milling Company Mill (Boulder County)

By C. F. LAKE, Manager
(Tungsten Mill)

In the treatment of our ores we use a straight concentration process, as they contain no other elements than the ferberite mineral and gouge or vein filling; hence the proposition is simply to separate the mineral from the gouge by concentration. After crushing our ore with the old type of Blake rock-breaker, it goes to the stamp battery; thence to Wilfley tables, which save the coarse mineral; from there to Frue vanners, which save the fines; after which the pulp goes to a tube-mill for regrinding, preparatory to treatment on a set of canvas strakes, or what is termed a "rag plant" in California mill practice, to make a further saving of the fine mineral.

From this it will be seen that there is nothing new in our process, and nothing that is of recent date, the Wilfley tables being the most modern of anything in use in the mill.

The Smuggler-Union Mills (Telluride)

By BULKELEY WELLS, Manager

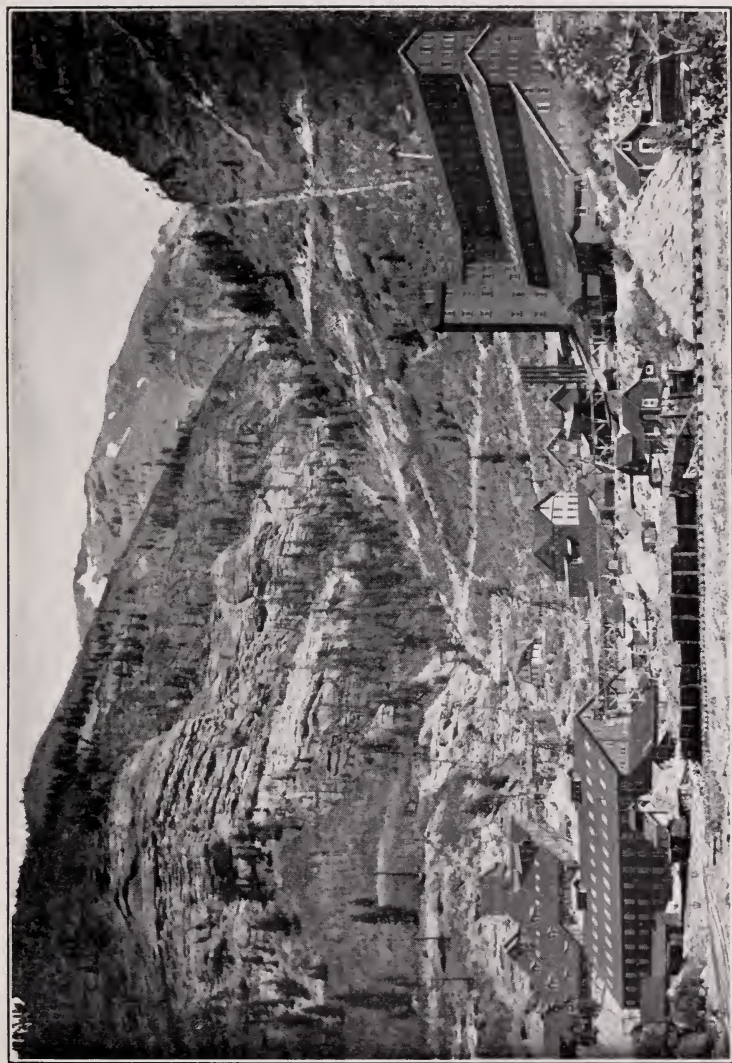
The ore from the mine is dumped on grizzlies having $1\frac{3}{4}$ -inch openings, the oversize going to a gyratory crusher (No. 5 Gates and No. 5 Bronze Ball, Chalmers and Williams, crushers used), where it is crushed to pass a 3-inch ring. The ore is then conveyed by an aerial tramway to the concentrating-mill, where the following treatment takes place:

Ore crushed by sixty 1,050-pound stamps through vertical slot rectangular opening screens; width of opening, .04 inch; diameter of wire, .028 inch. The pulp passes over amalgamating-plates, through Pierce amalgamators and quick traps, and is then elevated by air lifts to two Akins classifiers. The overflow from the Akins classifiers—everything passing through a 100-mesh screen—is sent to Callow tanks, thickened, and fed to nineteen 5-foot Triumph vanners. The concentrate product made by the vanners is shipped to the smelter.

The sands from the Akins classifiers, coarser than 100-mesh, are delivered to two hydraulic classifiers, classified into four sizes, and delivered to sixteen No. 6 Wilfley tables. A lead concentrate and an iron concentrate are produced and shipped to the smelter. The overflow from the hydraulic classifiers joins the overflow from the Akins classifiers. The middlings from the Wilfley tables are retreated on four No. 6 Wilfley tables that produce an iron concentrate, which is shipped to the smelter. The tailings from the middlings tables are reground in two 6' x 22" Hardinge mills. The tailings from twelve of the No. 6 Wilfley tables join the tailings from the middling Wilfley tables and are reground in the Hardinge mills above mentioned. The tailings from four of the sixteen Wilfley tables are sent to Callow tanks and vanners. As much clear water as possible is wasted from the Wilfley tables. The reground sands from the Hardinge mills are sent to two hydraulic classifiers and classified into three sizes. The coarse product is treated on two No. 6 Wilfley tables having Deister plateaus attached; the finer products are treated on six 5-foot Triumph vanners. The overflow from these hydraulic classifiers is sent to two Callow tanks, thickened, and fed to two vanners.

All tailings are retreated in the cyanide plant.

The cyanide plant is apart from the concentrating-mill. The tailings from the latter are conveyed to the cyanide plant by launders and classified in two Akins classifiers. The coarse sands—approximately 25 per cent of the tailings—flow to leach-



Smuggler Mills, With Mine in Distance, Telluride, Colo.

ing-vats, 40' diameter by 8' deep, and are treated with a strong solution—6 to 7 pounds KCN per ton of water—after which they are sluiced to waste.

The slimes and fine sands overflowing the Akins classifiers—approximately 75 per cent of the total tailings—go to five Dorr thickeners, each 40' diameter by 10' deep, for primary thickening, the clear, overflow water being used to convey the cyanide plant tailings to waste. The thickened slimes are filtered on two, 14' diameter by 12' face, Portland filters, mixed with cyanide solution, and pumped to four, 15' diameter by 45' deep, Pachuca agitators running in series continuously; the pulp overflowing from the last Pachuca going to three Dorr thickeners, 40' diameter by 10' deep; the overflow solution going to solution tanks, thence to clarifying-presses, where it is joined by the solution from the sands leaching-tanks and precipitated in the zinc boxes. The slimes from these latter Dorr thickeners are filtered by three more Portland filters, 14' diameter by 12' face, discharged to a launder, and washed to waste by the overflow water from the primary thickeners.

The solutions are precipitated with zinc shavings, the precipitate filtered by vacuum pans, then dried, and then melted in a tilting oil furnace. The bullion produced is marketed at the United States Mint, Denver.

The cyanide plant is exceptional for a Colorado plant, owing to the primary thickening and filtering of the slimes before applying cyanide solution. This method was adopted on account of the high percentage of base metals in the ore, which necessitated milling and concentrating in water rather than cyanide solution.

Empire Zinc Company Concentrating Plant

By A. R. LIVINGSTON, Superintendent

The concentrating plant of the Empire Zinc Company is situated about two miles south of Canon City, on a branch of the Santa Fe Railroad. It consists of a rough crushing and drying building, fine-crushing, magnetic separating, and wet mill. There are also a well-equipped experimental plant, a laboratory and office building, wash-house for the men, supply house, blacksmith and machine shops.

Power is furnished by electric motors, the current being 440 volts, 3-phase, 30 cycles, supplied by the Arkansas Valley Railway, Light and Power Company from its power plant in town.

The ores treated are zinc-lead-iron sulphides, the object being to make a high-grade zinc concentrate and lead and iron concentrates for shipment to the smelters. The capacity of the plant is 150-200 tons per day.

The ore as received from the mine is unloaded from the cars by hand or by a locomotive crane, and fed automatically to a 10 x 20 crusher, followed by three 36 x 16 rolls, the screening being done by inclined stationary screens. After being dried, it goes to any one of five storage bins. By belt conveyor it is carried to the fine-crushing plant, where it is crushed to the ruling size by one 36 x 16 and two 24 x 16 rolls, the screening being done on inclined stationary screens. By elevator the crushed ore is carried to screens, distributing the various sizes to bins over the magnetic separators. These machines, eleven in number, are the Rowand Type E Wetherill Magnetic Separator six poles. From these the zinc concentrates are obtained, the tailings free of zinc being shipped as iron or lead concentrates, unless they require further treatment in the wet mill. In this part of the plant there are installed one jig and eighteen Wilfley tables, with the necessary classifiers, tanks, shipping-bins, etc.

Water for the operation of the mill is obtained from the hills, being brought down by a gravity pipe line. Settling basins are used to reduce the loss as much as possible.

The experimental plant is for use in testing ores that may be brought to the attention of the company; also new machines or processes that give promise of being of use either in present or in future operations. It is of such size that tests can be made

in carload lots as well as on samples of a few pounds. The crushing is done by means of a crusher and two sets of rolls, with the necessary screens, elevators, and storage bins. The plant is equipped with jig, table, magnetic separators—all full size—flotation apparatus, and other parts that may be needed for determining the best methods of treatment.

The laboratory is very complete and well equipped, as a large amount of work must be done for both the commercial and experimental operations of the company.

A wash-house for the use of the men has been built. Individual lockers are furnished, so that each man has a place to keep his change of clothes. Shower baths and basins, with hot and cold water, are part of the equipment.

Care has been taken to guard all parts of the mill where there may be the slightest possibility of an accident. Runways and stairways are placed where required, and furnished with railings. Gears, pulleys, and belts are protected by wire or wood guards and covers, so built that they can be removed and replaced readily. Electric lights have been installed wherever needed, so that at night the men may be in no danger while attending to their duties. All electric wiring is in metal conduit, to reduce the risks from fire, and a sufficient supply of hose and chemical fire-extinguishers has been distributed at proper places throughout the plant.

This plant has been in operation since 1901, and is running full time at present.

Liberty Bell Mill Practice (Telluride)

By W. E. TRACY, Superintendent

The chief changes in practice, from that described in the last report, are the local treatment of concentrate and the discontinuance of amalgamation.

The ore is crushed at the mine to $2\frac{1}{2}$ inches in a No. 6 Tel-smith primary breaker. It is delivered to the mill and distributed in the mill bins by tramway. The mill contains eighty 850-pound stamps on concrete blocks, and treats about 520 tons per day. Since the discontinuance of amalgamation, fine crushing by the batteries is not essential, and this tonnage will be put through sixty stamps. The exact type of screen to secure this duty has not been determined.

A 2-pound cyanide solution is used in the batteries and throughout the mill. The entire flow from the batteries passes to a 48-inch Akins classifier, and the sands through a 5' x 22' Abbee tire type tube mill, which acts as a rougher before concentration.

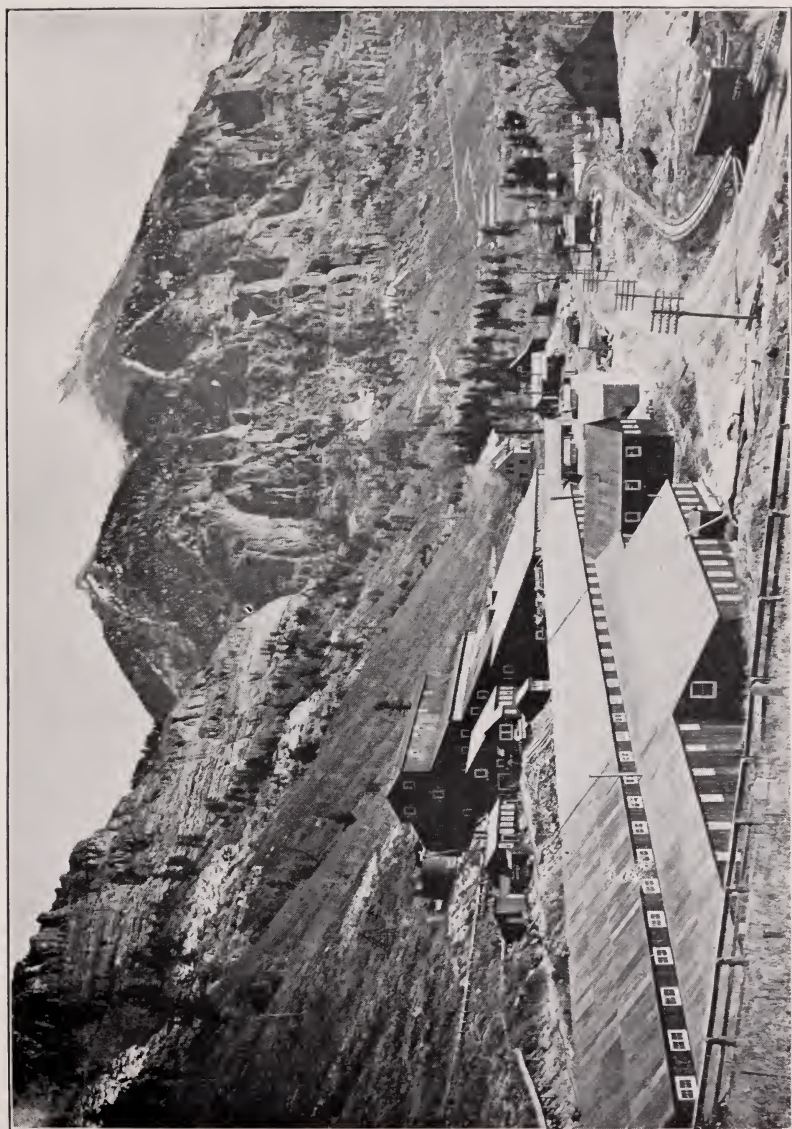
The pulp is then classified in four Richards vortex classifiers, fourteen 6-foot cones, and a 12-foot Dorr thickener; the coarser products being concentrated on fourteen Wilfley tables and the finer on ten Deister No. 3 tables. Coarse table tailings are reground in two 5' x 22' tube mills, and the granular sands reconcentrated on 4 Wilfley tables. Concentrates from all tables gravitate to the treatment plant.

All table tailings and cone overflows are combined and pass to seven 33' x 10' Dorr thickeners, two of which are equipped with an extra deck. The thickened pulp passes through six 17-foot and two 33' x 10' Dorr agitators, operated continuously in series.

Agitator tailing is filtered in a Moore vacuum filter plant, the tailings discharged to waste, and the filtrate clarified through an extra set of filter leaves and precipitated on zinc shavings. Precipitate is acid-treated and melted in two No. 275 Case tilting furnaces. Barren solution from the zinc boxes, and thickener overflows, are returned to the mill.

Cyanide is added to the battery feed solution, and in the middle of the agitation period, which is about twenty hours, lime is added as emulsion ahead of the thickeners.

Solutions are maintained at a temperature of about 70° F. in the mill and raised to 80° F. in the agitators.



Liberty Bell Mill, Telluride, Colo.

The concentrate treatment consists of grinding to pass 200-mesh in a 4' x 10' tube mill, agitation for forty-eight hours in four small Pachuca agitators in series, and passing the agitator tails through two 20' x 4' counter-current Dorr thickeners. Further changes of solution have not showed any great benefit. The tailing from this plant was at first discharged into the mill agitating system, but it is doubtful if any further extraction was secured, and lately it has been shipped to the Durango smelter at a slight profit, the decrease in freight and treatment charges on account of its low-grade being about equal to the cost of the local cyanide treatment.

The Smuggler Leasing Company's Concentrating Mill

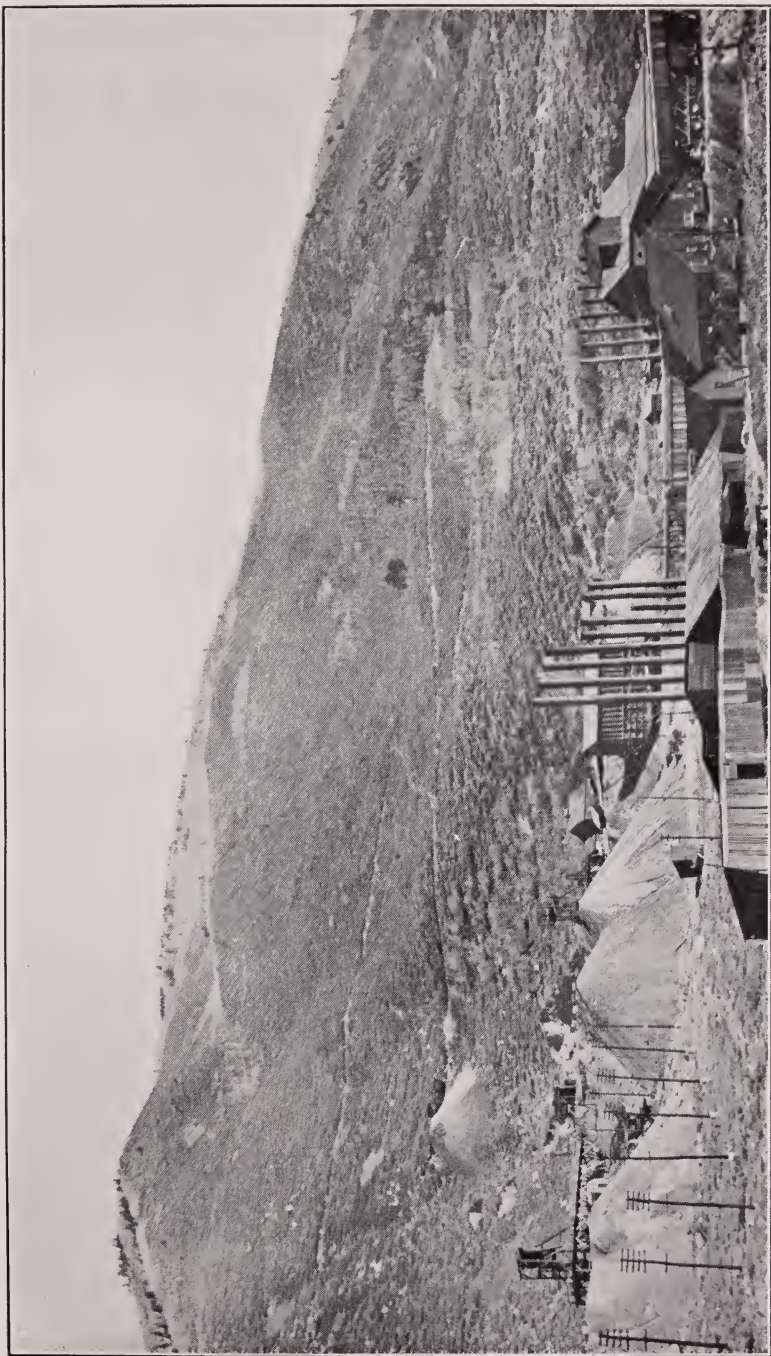
By CHARLES E. ANDERSON, Manager

After years of experimenting with various types of smelters, and leaching and concentrating plants, the Aspen mining district has abandoned all in favor of the concentrating mill under operation by the Smuggler Leasing Company. This mill is of the coarse-crushing and jigging type, of 360 tons daily capacity. It was constructed about twenty years ago by builders who followed the plans of concentrating mills used in Germany.

The mill was located on a flat in the town of Aspen, to suit the German design, losing the simplicity and economy which are always considered by taking advantage of topography in designing mills built in the Rocky Mountains. Under this adverse location, the mill has been continually improved by the introduction and rearrangement of machines most suitable to advanced theories of liberating and separating the disseminated silver-lead minerals with the least possible loss.

At present the operation of the mill is as follows: The ore up to the size of 12 inches is dumped from the railroad cars and conveyed up to a shaking grizzly, from which the oversize is crushed through a 12 x 20 Dodge crusher, and the undersize elevated to a storage bin. The crusher discharge is sized by a 1-inch perforated trommel, from which the oversize is reduced to 1 inch and smaller by 16" x 30" rolls, and the undersize elevated to storage bins. From the storage bin the ore is automatically discharged into a line of four ¾-inch to 2 mm. duplex sizing trommels, from which the coarsest oversize is fed to two one-compartment, and the oversize from the finer trommel fed to six four-compartment, all Crank Arm Accelerated Plunger Jigs, making concentrates and middlings. The undersize from the trommels is discharged into a square-pointed separating classifier, from which the spigot product is discharged onto a Callow 30-mesh screen, and the overflow to a four-compartment pointed settling-tank, from which spigots feed three belt vanners, the overflow discharging into the tailrace.

The oversize from the callow screen is fed to a four-compartment Harz Eccentric Plunger Jig, making concentrates and middlings; and the undersize is discharged into a launder classifier. The launder classifier spigots feed a battery of six riffle tables, and the overflow is discharged into a large conical settling tank,



Smuggler Leasing Co. Mill, Aspen, Colo.

from which the spigot feeds three corrugated belt vanners, the overflow discharging into the tailrace.

The middlings from the jigs are reground, from the two coarse-ore compartment jigs in rolls, and from the other jigs in six 5-foot Huntington, 30-mesh screen mills. The recrushed product from the rolls is distributed in the battery of sizing trommels, and the 30-mesh product from the Huntington mills is discharged into a launder classifier, from which the spigots feed eight riffle tables, making concentrates and tailings; and the overflow is discharged into a four-compartment pointed classifier. The spigots from the classifier feed four belt vanners, making concentrates and tailings, and the overflow is discharged into the tailrace.

The mill is equipped with two separate automatic sampling machines at the head end of the mill; one of these machines to sample small lots of ore, and the other to sample the daily tonnage. The tailrace is also equipped with a sampling machine under lock and key to check the millmen's samples.

The concentrates are wheeled into railroad box cars without artificial drying.

Power for the mill is furnished by the Roaring Fork Electric Light and Power Company.

The saving of silver and lead values during the last twelve months averaged 92 per cent, and the cost of milling, including repairs, 55 cents per ton.

The Wellington Mines Company's Mills (Breckenridge)

By R. M. HENDERSON, General Manager

The mills of the Wellington Mines Company are located in French Gulch, about two miles east of Breckenridge. They consist of two mills: No. 1 a wet concentrating mill of 125 tons' capacity, and No. 2 a magnetic separating mill of 60 tons capacity.

No. 1 mill is equipped with one 9" x 15" Blake crusher; one set of 36" x 16", one set of 27" x 14", and one set of 20" x 12" rolls; six six-compartment and one three-compartment Harz jigs; nine concentrating tables, four sizing trommels, one six-compartment hydraulic classifier; and the necessary conveyors, elevators, settling-tanks, pumps, etc.

No. 2 mill is equipped with one 11-foot diameter, five-hearth Hereshoff roasting furnace used as a drier; one sizing trommel; one set of 27" x 14" rolls; one 14-foot-diameter, seven-hearth Walker Manufacturing Company, McDougal type, roasting furnace; one 17' x 6' Walker cooler; three Ball Norton belt-type magnetic separators; one four-compartment hydraulic classifier; five concentrating tables; one 3-foot Hardinge ball mill; one 3' x 3' tube mill; one Morse rarefied-air dust collector; and the necessary feeders, conveyors, elevators, pumps, fans, etc.

The crude ore is treated in the concentrating mill, recovering the greater part of the lead, eliminating the silica, and sending the iron-zinc product to the magnetic mill for further treatment. The coarsest material going to the jigs passes through 5/16" round perforations on trommel No. 1 and tails over 4-mesh No. 12 wire on trommel No. 2. The finest material treated on jigs is the product of the No. 6 or coarse spigot of the classifier, which takes the undersize of 12-mesh No. 19 wire on No. 4 trommel. No material is sent to Nos. 2 and 3 rolls except from the jigs, after the free silica has been eliminated.

The crude ore delivered to No. 1 mill assays about 5 per cent lead, 17 per cent zinc, 21 per cent iron as sulphides, 2 per cent iron as carbonate, 2.5 per cent lime, 19 per cent insoluble, and 3 ounces of silver per ton. The lead concentrates carry 10 to 12 ounces of silver per ton, 43 per cent wet lead, 18 per cent iron, 5 per cent zinc, and 2 per cent insoluble. The tailings average 0.7 per cent lead, 4.5 to 5 per cent zinc, 10 to 11 per cent iron, and 5 per cent lime. The zinc-iron middling product carries about 2.25 per cent lead, 24 per cent zinc, 27 per cent iron, 1 per cent lime, 3 per cent insoluble, and 42 per cent sulphur.

This material is sluiced into bins at the magnetic mill, where it is dewatered to 4 per cent moisture, then shoveled into a tram car, weighed, and fed to the drier. From the drier it is crushed to pass 14-mesh and sent to the roaster, which discharges directly into the cooler. From the cooler it is elevated to a small trommel, which takes out the fused particles, and then sent to Nos. 1 and 2 separators. The separators make three products: an iron product, which, owing to excessive freight rates, it does not pay to save; a middling product, which is sent to the Hardinge mill; and a zinc-lead product, which goes through the classifier to the first four tables. The middling from the separators, after being ground in the Hardinge mill, goes to No. 3 separator. The iron product and the zinc-lead product of this separator join the like products from the first two separators. The tables make three products: a lead and a zinc product, which go to separate bins; and a lead-zinc middling, which goes to the tube mill and, after grinding, is returned to the classifier. The slimes from the first four tables are settled in a 16-foot "V" tank and treated on No. 5 table.

The average assay of the products of this mill is as follows:

Lead concentrates: 22 ounces silver, 66 per cent lead, and 7 per cent zinc.

Zinc concentrates: 2.5 ounces silver, 48 per cent zinc, 1.5 per cent lead, 10 per cent iron, 0.7 per cent lime, 3.5 per cent insoluble.

Iron tailings: 3 ounces silver, 4.2 per cent zinc, 1.2 per cent lead, 52.5 per cent iron, 1 per cent lime, 3 per cent insoluble.

The middling product sent to the Hardinge mill from Nos. 1 and 2 separators assays about 4 per cent lead and 10 per cent zinc.

We are adding a few details of possible interest concerning some of the operations of these mills:

The crushed ore in the stock bin of No. 1 mill is sometimes quite damp and would hang in the feeder chute, or bridge above it, allowing the mill to run almost empty at times before being discovered. To prevent this, an endless $\frac{3}{4}$ -inch coil chain has been rigged up to travel through the ore on about the angle of the bottom of the bin, out through the feeder chute over an idler and up to the top of the bin, where it works in an 18-inch pocket sheave wheel keyed on to a $3\frac{7}{16}$ -inch shaft. This shaft is driven by heavy spur, bevel, and worm gears. The chain travels about 16 inches in ten minutes, and while it requires very little power to operate, owing to its slow motion, the strain on the chain is very heavy, and the driving mechanism and framing must be substantial. We have on the sheave wheel shaft a 25-inch diameter, $5\frac{1}{2}$ -inch-face, $1\frac{3}{4}$ pitch spur gear, and it is none too heavy. This rig has worked very successfully, and has reduced the work of the mill-man and increased the tonnage milled.

The throughs of the 12-mesh screen on No. 4 trommel are delivered to a chain drag dewaterer, which in turn delivers to the six-compartment classifier, the overflow going to Callow settling tanks. The chain used in the dewaterer is a No. 88 detachable

link, with attachments every other link, to which are bolted hickory flights 12" x 3" x $\frac{3}{4}$ ". The shaft which carries the lower sprocket wheel passes through stuffing boxes attached to the sides of the tank. The drag travels 15 feet per minute and delivers enough water with the pulp to cause it to flow freely in a 45 degree launder. The chain and flights last about three months, and are cheaply and quickly replaced.

The classifier is built on the principle of the Meinecke classifier, though very much in the form of the Richards pulsator classifier; but, instead of a screen, it has the bottom, under the compartments, inclined at an angle of 45 degrees. Horizontal slots in the bottom allow the under-water to be introduced below the descending pulp. The first compartment has an overflow spout, from which are drawn the slimes and very fine material. The other compartments are fitted with spigots, which discharge a fixed quantity of water and pulp. The first two compartments discharge all of the muddy water and slimes, and the water discharged with the material from the remaining four compartments is almost clear. We have tried introducing the under-water through a Richards pulsating valve, and have tried shaking the classifier with an ordinary eccentric, but the only improvement in the operation noted was the prevention of an occasional choke caused from a flood of material. The classifier makes no hutch product, has given excellent satisfaction, and does equally good work on a light and on a heavy feed without any change of adjustment.

In Mill No. 2 several feeders were tried for delivering the zinc-iron middling to the elevator which supplies the drier. The one which has given the best satisfaction is made of a 9-inch, solid-cast, flight spiral conveyor 22 or 23 inches long, which runs three revolutions per minute. The flights of this conveyor last five months. For convenience in replacing these flights, they should be bored $\frac{1}{64}$ inch larger than the shaft, cast with locking lugs for the center section, and the two end sections fastened with bolts passing through the hub of the flight and the shaft.

The Hereshoff furnace has proven efficient as a drier. It runs at a speed of four revolutions per minute, requires about two horse-power to drive, and evaporates seven to eight pounds of moisture for each one pound of Bowie coal. Seventy to eighty tons of middling, carrying 4 to $4\frac{1}{2}$ per cent moisture, can be easily dried per twenty-four hours. The steel detachable rabble teeth last about twelve months. When operations were started, the hot gases from the roaster were passed through the drier, and while they were sufficient to dry the ore, the weak acid formed by their contact with the damp ore caused more expense from loss of time and for repairs than the cost of fuel.

A large part of the material coming from the drier is coarse, and must be crushed and sized to about 14-mesh. The trommel used for the sizing is 30 inches diameter by 6 feet long, and is covered with No. 20 gauge sheets with diagonal slot perforations

.049" x 5". What are known in flour-milling practice as inter-distributors are used in this trommel. These prevent the material from piling up on the up-going side of the trommel, and carry part of it over, discharging on the down-going side, adding about 50 per cent to the capacity, and increasing the life of the screen very materially. The punched sheets last from eight to ten weeks, and no trouble is experienced from blinding.

The roaster is driven four revolutions per minute, and it takes about forty-five minutes for the ore to pass through the furnace. Roasting begins on the second hearth, and the heat is greatest on the sixth hearth, averaging about 600° C. The feed carries 41 to 43 per cent, and the roasted product 30 to 33 per cent sulphur.

Considerable experimenting was done on the middling product from Nos. 1 and 2 separators, to determine the best machine for grinding it. This product consists partly of crystals of two minerals which have not been broken free, but mostly of particles of zinc or lead fused to particles of iron by the heat of roasting. It was thought that a mill with a rubbing action would be desirable, and we found that the material reduced on a disc sample grinder gave the best results on the separator—much better than when reduced on rolls. As it was not practical to use a machine of this kind, a small ball or tube mill was decided upon. By running this mill slowly, twenty revolutions per minute, very good results are obtained. The middling, after grinding, goes to No. 3 separator, which has magnets 50 per cent stronger than those of Nos. 1 and 2. The zinc product of this separator assays 2 to 3 per cent lower, and the iron product $\frac{1}{2}$ to 1 per cent higher, in zinc than similar products from the first separators. The zinc-lead middling from the tables is similar in character to the separator middling, except that it consists of zinc and lead only. It is ground on a short 3-foot-diameter tube mill, running nineteen revolutions per minute, and returned to the system at the classifier.

The "V" settling tank is rigged up with an 88-sprocket chain that travels lengthways in the bottom from overflow to intake ends, at a speed of about 18 inches per minute. One spigot located under the forward sprocket wheel is sufficient to keep the tank entirely clear of accumulations. The overflow water is practically clear. A weighted idler resting on the upper strand of the chain prevents sagging of the lower strand, and consequent wear to the bottom of the tank.

The power required for the mills is as follows:

Mill No. 1

One 9" x 15" Blake crusher.

One 10" x 6" bucket elevator, 45-foot centers.

One 30-inch belt conveyor, 45-foot centers.

One shaking feeder.

15.7 HP.

One set 36" x 16" rolls.
One set 27" x 14" rolls.
One set 20" x 12" rolls.
Three 8" x 5" bucket elevators, 45-foot centers.
Three feeders.
Four trommel screens.
Six 6-compartment Harz jigs.
One 3-compartment Harz jigs.
 (Size of compartments, 32" x 18".)
One drag dewaterer.
One classifier.
One 400-gallon centrifugal pump, elevating water 56 feet.
 54 HP.
Six Wilfley tables.
Two Card tables.
One Deister table.
One 2-inch Card sand pump, elevating 34 feet.
One 54" x 6" Frenier sand pump, elevating 16 feet.
One Scobey tailings sampler.
One 10" x 6" bucket elevator, elevating 28 feet.
 15.5 HP.

Mill No. 2

One 11-foot, 5-hearth drier.
One set 27" x 14" rolls.
One 14-foot, 7-hearth roaster.
One 17 ft. x 6 ft. cooler.
Three magnetic separators.
One 12-inch spiral conveyor, 12 feet long.
One 10-inch suction fan.
One 15-inch suction fan.
One 14-inch belt conveyor, 15-foot centers.
Four 6" x 4" bucket elevators, 30-foot centers.
One 5" x 3½" bucket elevator, 27-foot centers.
One 3-foot Hardinge ball mill.
One 1½" centrifugal water pump, elevating 40 feet.
 23 HP.
One 3 ft. x 3 ft. tube mill.
Four Wilfley tables.
One Card table.
One shaking launder.
One 1½-inch centrifugal sand pump, 30-foot lift.
One 6-inch suction fan.
 7 HP.

The Argo Tunnel

By RENS E. SCHIRMER, Manager

The Argo (Newhouse) Tunnel is located in Clear Creek and Gilpin Counties, Colorado. The portal is in Idaho Springs, and the tunnel extends in a northwesterly direction for a distance of 21,968 feet, passing under the noted mining districts of Seaton Mountain, Russell Gulch, Quartz Hill, Nevadaville, and Gunnell Hill; its present breast being vertically beneath Eureka Gulch, about 3,500 feet west of Central City.

Preliminary operations in the tunnel were started by hand work in September, 1893. On January 1, 1894, machine drills were employed in the driving of the tunnel, which was continued during intermittent periods until November 18, 1910, when the present terminus was reached. The actual time employed in driving was nine years and seven months. The tunnel is a cross-cut for its entire length through Idaho Springs Schist and a granite gneiss. It intersects the numerous veins of the districts through which it passes, in a general direction at right angles to their strike and at an average depth of about 1,800 feet below the surface. The cross-section is 8 by 8 feet in the clear for a distance of 13,100 feet from the portal, and 5 by 8 feet for the remainder of its distance, with the exception of sidings which have been excavated at frequent intervals. The tunnel is driven on a grade of one-half of 1 per cent, to provide for drainage and to equalize the pull of the loaded cars out against the empty cars on the inward trip. The drainage water is taken care of by a ditch in the floor of the tunnel, of an average cross-section of 12 x 18 inches, which is more than ample to take care of the entire flow.

The tunnel is equipped with a single track of 18-inch gauge, laid with 30-pound rail. A 500-volt direct-current trolley system is used for haulage purposes, and this power can also be employed for driving small hoists and fans. Two 7-ton Westinghouse locomotives are in use for the main haulage in the tunnel, and smaller locomotives for switching. The cars used are 52 cubic feet, or 3-ton solid box cars, which are handled in trains of from twenty to forty-five cars each. They are automatically dumped by means of rotary tipples for the ore and a movable crane for waste. At the portal is located a 1,000 cubic feet motor-driven compressor, furnishing compressed air service to the various mines along the line of the tunnel. There is also a well-equipped blacksmith and machine shop, where custom work is done for operators.

The tunnel not only drains the mines adjacent to it, but furnishes means of natural ventilation for those connected. The

transportation service is similar to that of a railroad, the company placing empty cars on the sidings adjacent to the mines, and delivering the ore to the Argo Mill, situated at the portal, or into the cars of the Colorado & Southern Railroad, 100 feet distant, for transportation to the smelters or other mills of the district. Waste is transported at the rate of 1 cent per cubic foot of the capacity of the cars, or at about 17 cents per ton, which includes the dumping. Ore is hauled at a cost varying according to its value, and ranges from 40 cents to \$1.25 per ton; however, practically all of the ore shipped bears a transportation charge of but 60 cents per ton.

The various facilities which the tunnel offers makes possible the mining of the vast number of veins which it intersects for a very little outlay for equipment. A hoisting plant is not required, as the ores are dropped by gravity to the tunnel level, and there dumped into cars furnished by the Tunnel Company. Compressed air is also furnished operators for drills and hoists, practically at cost, thus precluding the necessity of an expensive compressor installation. The comparatively low transportation charges, together with the fact that the Argo Mill purchases all grades of ores at a fixed schedule, make the mining of the low-grade ores of this district an economical possibility.



Standard Chemical Co.'s Concentration Plant, Montrose County.



Standard Chemical Co.'s Radium Manufacturing Plant, Cannonsburg, Pa.

Radium Plant of Standard Chemical Company

By JOSEPH M. FLANNERY, President

Radio-activity is a property of some forms of matter which is due to a process of spontaneous atomic disintegration taking place. Most forms of radio-active matter are characterized by the sending out of rays. These rays are of three types: the easily absorbed or alpha rays, which are positively charged helium atoms shot out with terrific velocity from the disintegrating atoms; the more penetrating beta rays, which consist of negative electrons (particles 1,700 times smaller in mass than the hydrogen atoms) moving with a velocity approaching that of light; and the very penetrating gamma rays, a form of radiation analogous to the Roentgen rays. When the radio-active atom disintegrates or transmutes, one or several of these rays are emitted, the remainder of the atom constituting a new atom, which may again undergo another transmutation into the next product. At present there are about thirty-three recognized radio elements, which group themselves in three families comprising the decay products of uranium, thorium, and actinium. Radium is a decay product in the uranium series.

Radium is a metallic element that is transmuting at a much more rapid rate than is uranium. Considering equal weights of uranium and radium element, in a year 0.00000000014 of the total quantity of the uranium, and 0.00035 of the total quantity of radium, will decay. The ratio of the quantity of uranium to the quantity of radium decaying is 2,500,000. For equal weights of radium and uranium, there are enormously more rays from the radium than from the uranium, since a larger proportion of all the radium atoms undergo a transmutation in any given interval of time.

Carnotite, a uranyl vanadate occurring in southwestern Colorado and southeastern Utah, is the main source of the world's supply of radium ore. For each 3,000,000 parts of uranium metal there is one part of radium metal in carnotite. Thus a carnotite with 1 per cent of uranium metal (1.18 per cent U_3O_8) would carry one gram of radium element in 330 tons of ore.

Radium in its chemical properties is closely related to the alkaline earth metals, and it resembles the element barium so much that radium compounds are separated from the corresponding barium compounds only with the greatest difficulty. Com-

mercially radium is used in the form of its salts, the commonest being the bromide, sulfate, chloride, and carbonate.

Until recently the milligram of pure crystalline radium bromide ($\text{Ra Br}_2 \cdot 2\text{H}_2\text{O}$) has been the standard for radium salts. This salt contains 53.6 per cent radium element. Pure radium chloride (Ra Cl_2) contains 76.1 per cent of radium element; pure radium sulfate (Ra SO_4) contains 70.2 per cent radium element, and pure radium carbonate contains 79.0 per cent radium element. One milligram of radium element corresponds to 1.87 milligrams of bromide ($\text{Ra Br}_2 \cdot 2\text{H}_2\text{O}$); to 1.42 milligrams of the sulfate; to 1.31 milligrams of the chloride; and to 1.265 milligrams of the carbonate.

As other salts than the bromide have come into use, the custom has grown of describing them in terms of their radium-element content, since the radium element is the valuable constituent of the compound. This obviates the confusion that would otherwise arise in dealing with the various radium salts, which contain a different amount of radium in equal weights of the salt.

The Standard Chemical Company is the largest producer of radium in the world. The output of radium salts produced by this company is three times greater than the aggregate output of all the rest of the radium-producers in the world.

The Standard Chemical Company produces radium from carnotite from Colorado and Utah. The company owns many claims in these carnotite areas, and mines its own ores. At present from six to ten tons of ore must be mined in order to secure one ton of shipping ore. After mining and sorting, the ore is packed by burro and wagons to the concentrator. After undergoing a mechanical concentration, the ore concentrates are shipped by wagon to Placerville. The concentrator is sixty miles from Placerville, and the round trip by wagon takes a week. From Placerville the ore is shipped to the company's reduction mill at Canonsburg, Pa., where the ore is treated. After the radium has been extracted from the ore, together with the barium, the radium-barium salt is sent to the Radium Research Laboratory in Pittsburgh, Pa., where it is subjected to a long process of concentration, the radium being finally separated in the form of 60 to 75 per cent pure radium salt.

To produce radium from carnotite involves the treatment of enormous quantities of ore, because the greater amount of carnotite ore is of a very low grade. Ore containing 1 to 1.5 per cent of uranium oxide (U_3O_8) can be worked, although 2 per cent ore is more desirable. The world's future supply of radium will probably come from these carnotite deposits in Colorado and Utah; and, since the ore is mainly low-grade, it will be necessary to work up material containing 1 per cent or less of uranium oxide.

To produce a gram of radium element in the form of pure radium salt requires the working up of 400 to 800 tons of ore, and the treatment involves the use of almost twice this weight of chemicals—exclusive of water—and about 150 days are required for the production of the finished radium ready for delivery.

From this standpoint of cost of production the present price of radium is exceedingly low. At present (January 1, 1915) the market price is \$120 to \$160 per milligram of radium contained in a preparation. Barring a few sales by the Curies and Giesel in the earliest days of radium production—where the selling price bore no relation to the cost of production—the price for radium in the past few years has been between \$187 and \$280 per supposed milligram of radium element.

The radium produced from January 1, 1914, to January 1, 1915, in the Radium Research Laboratory of the Standard Chemical Company, contained 18,000 milligrams (28,350 milligrams equals 1 ounce avoirdupois) of pure crystalline radium bromide ($\text{Ra Br}_2 \cdot 2\text{H}_2\text{O}$). This corresponds to 9,600 milligrams of actual radium element in the radium preparations, all of which consisted of 50 to 75 per cent pure radium salts.

The production at present is at the rate of 2,800 milligrams of pure radium bromide per month (1,500 milligrams of pure radium element), and before the present European war cut off a large part of the market for radium, making necessary a corresponding curtailment of production, the output of radium by the Standard Chemical Company in the year 1914 was conservatively estimated at between 22,400 and 24,200 milligrams of pure radium bromide, corresponding to from 12 to 13 grams of radium element.

The war resulted in closing the mill for three and a half months, and the radium output for 1914 was reduced to about 10 grams of radium element.

In 1915 it is expected that the output will average 1,500 milligrams of radium element per month, making a total of 18 grams of radium element for the year. This is equivalent to 33,600 milligrams of pure radium bromide—a quantity equal to one-half the world's total present accumulation of radium.

Much of the radium sold earlier than 1912, and some in the market since, has been found to have been greatly overrated as regards purity. Now that the international radium standard has been prepared, all preparations are standardized by gamma-ray comparisons on this basis, and purchasers should demand a guarantee of the actual radium-element content of preparations, or a certificate of measurement by the Bureau of Standards, in order to assure themselves of what they are getting.

In spite of the great difficulty in preparing radium, and the really small quantity of it in an available form, a great deal of work has been carried out since 1903 on the therapeutic applica-

tions of the radium rays, and it is now conceded that radium has a definite place in therapy. It has been used very successfully in the treatment of certain forms of cancer and in the treatment of a great many non-malignant skin growths, and lately radium is even finding a considerable use in internal medicine.

Radium Industry

LAND-WITHDRAWAL SCHEME INJURIOUS TO COLORADO

We had been mining radium-bearing ores (carnotite and pitchblende) in Colorado since 1888, and the world had paid little attention to the trials and difficulties of the miner in discovering and treating his ores, until December, 1913, when the cry arose in Washington that the radium miner was unpatriotically shipping all his ores out of this country, while thousands of sufferers of that dread disease, cancer, were dying annually in the United States for want of this wonderful element, which our American doctors could not buy. A bill was introduced in Congress to withdraw all radium-bearing lands from public entry, and authorizing the government to erect a plant for the treatment of all ores mined on public lands, for the use of the army and navy hospitals of the United States.

When the first news of this legislation reached me through the public press, I saw in it an attempt to destroy an important and growing industry in this state. I realized that it was the entering wedge to a system of leasing all our public lands—the most damnable policy ever concocted against the West. I also saw that the scheme had been carefully worked out, and that the plan was to rush it through on a wave of public sentiment.

Behold the picture held up to the view of the American people! Reduced to a skeleton, the argument of these philanthropic patriots was as follows:

“A European radium trust is attempting to gain a corner on all our radium lands. Scientists have proved that there is less than an ounce of radium in the whole world. When the European trust has cornered all our radium and radium lands, the United States will be helpless. Radium is a positive cure for cancer. Our good friend, Dr. Howard A. Kelley, who has made many marvelous cures of cancer with radium, is co-operating with the government, because he believes the government should control this industry. Think of our army and navy hospitals lacking this wonderful element, while Europe is taking it all from us! The United States should immediately head off the radium trust by holding these lands. Then we should erect a plant, learn the secrets of manufacture, and do a great philanthropic work. This wonderful element is too precious to be exploited by private capital. It belongs to the thousands of sufferers in the United States, most of whom are poor and cannot afford the present high cost of treatment.

"That good patriot, Dr. Kelley, has promised to come to the aid of the government by advancing money for the construction and equipment of a plant for radium manufacture. We must act quickly or it will be too late."

PRESS AGENTS BUSY

Think of this argument being spread by the United States Geological Survey and the United States Bureau of Mines! Sentimental people wept over it; newspapers grabbed at it.

There is no better publicity service in the world than that of the government bureaus in Washington. These bureaus employ press agents, designated as such, who have the ear of all the influential newspapers in the United States. Recognizing a "good story" and believing the motives of the government officials disinterested, the correspondents accept their ex-parte statements, when they are backed by much apparent fact. The tactics of the circus press agent were employed to influence the members of Congress.

COLORADO PROTESTS

I called a meeting of the mining men, bankers, and business men of Denver to consider the proposed legislation. The meeting adopted resolutions protesting against the proposed withdrawal of these lands. These resolutions were telegraphed to the Secretary of the Interior. Similar resolutions were adopted by commercial bodies and miners in many parts of the state.

When the bill came on for hearing before the committees of the two houses of Congress, I appeared as a witness. At those meetings also appeared many mining men of Colorado. Senators John F. Shafroth and Charles S. Thomas, and Representative Edward T. Taylor, ably assisted in combating the legislation in committee.

We were successful in showing that no European radium trust existed; that all the mining companies operating in the carnotite fields were American, financed and controlled by Americans, except one company, which obtained its capital in Europe, but whose officers were Americans—and this company mined only a small percentage of the carnotite ores produced. But even if it had mined a greater percentage, would it have been fair to interfere with its operations? Much of the capital obtained for our gold, silver, lead, copper, and zinc mines comes from Europe. We are glad to get it anywhere. The same is true of capital invested in railroads, street-car companies, and other public works.

However, when we proved that there was no European radium trust, the friends of the legislation changed their tactics. They now charged that there was an American radium trust, either existing or in the making. The mere fact that there were more

than one hundred individuals and companies operating in the fields, and that the carnotite area was thirty times as large as represented, was sufficient refutation.

Again they changed tactics. They declared that all the ore was being shipped out of the country. I produced railroad records, which showed that 60 per cent of the ore mined was retained in this country and treated here. They charged that radium ore was not successfully treated in this country, but Doctor Kelley admitted on the stand that the United States produces "the very best" radium.

NO MONOPOLY

Next they charged that the company which had the American process would have a monopoly. We assumed that the government believed this company should surrender this process to the public, although it cost \$650,000 to produce the first two grams of radium.

The owner of that process offered to supply the United States government with enough radium for the use of the army and navy hospitals at a price lower than that at which the government could hope to manufacture it. The offer was refused, in spite of the fact that the government had not yet begun to work out a process, did not know how long it would take, or whether it would ever be successful; and in spite of the fact, also, that thousands of people would die meanwhile of diseases which could be helped with radium. Another private corporation was engaged at that time in working out a process. There are several places in Europe where processes have been worked out. It is evident that monopoly of a process was impossible, and that capital and brains could supply one.

Dr. Kelley testified to the value of radium in cancer cure. He had photographs of cures, but he did not produce photographs of those who died under treatment. He treated one member of Congress during the hearing, and the patient died.

The price of radium was the next plan of attack, but it was shown by the testimony of government witnesses, under questioning, that the American price of chemically pure radium is considerably lower than the price at which it is sold in Europe.

It was discovered at the hearing that Dr. Kelley was attempting to arrange with the government to build a plant at a cost of \$300,000, the funds to be furnished by himself and associates, on condition that the government would use the plant to solve a process and in return give him the first seven grams of radium produced. Bearing in mind that radium then was worth \$120,000 a gram, and that scientists had said there was less than an ounce in the world, the philanthropy of investing \$300,000 to receive \$840,000 worth of radium in return does not impress me. Talk of radium trusts!

EXTENT OF DEPOSITS

But the greatest blow of all was the fact that the United States Bureau of Mines and the United States Geological Survey experts had been maintaining that radium existed only in the Paradox Valley, in Montrose County, Colorado, and a small part of Utah, and that the ore "occurred in small pockets, producing a wagon-load of ore here and there." I showed that the carnotite area of Colorado then was 150 miles long and five miles wide, extending through Montezuma, Dolores, San Miguel, Montrose, Mesa, Rio Blanco and Garfield Counties, and that we were producing hundreds of tons from some claims. I also contended that carnotite ore undoubtedly would be found in other parts of the state, if the prospectors were not interfered with. This prediction has been borne out by developments.

I maintained, and still maintain, that there is enough radium in Colorado to supply the world.

The result of the agitation was that thousands of prospectors took to the field, and in a few weeks discovered carnotite in a total of twelve counties in Colorado. Discoveries also were made in other states. The Canadian government offered a reward to any prospector that would find radium-bearing ore.

The cry of a radium trust is bosh. Almighty Providence is not in the retail business. There is enough of every element in the world for the use of the world, although we do not readily find it.

LEASING IS ULTIMATE OBJECT

As stated before, I perceived in this proposed legislation an attempt to place all our mineral lands under a leasing system; and it was not long thereafter that a bill was introduced to accomplish that end. This scheme has been fostered by the bureaucratic heads in Washington for some time, and they have been able to convince a large number of the people of the United States, not familiar with mining, that it is the only sane plan of conserving our mineral resources. It is a habit of Washington bureaus that they can begin with a desk and a chair and in ten years grow to a building full of offices. If the mines of the West are placed under the leasing system, it means more authority and more jobs for the bureaus. The miner is too busy with his work and is lacking in funds to combat the bureaus' press agent work. But if any traveler comes from the East, he will be impressed by the fact that our citizens are not all rich, and he must wonder what fools we are, not to be rolling in wealth when there is so much of it lying out of doors, belonging to the government.

Back of it all is the fine hand of the Pinchot type of conservationist, who is so busy looking after the welfare of posterity, and incidentally the building-up of bureaus, and the plaudits and votes of the present generation, that he would hamper the growth of the western states.

ALL MINERAL LANDS INCLUDED

Analyzing the bill, we found that, by a stretch of the imagination, any mineral land could be classed as radium land, since most of our mineral land is radio-active to a degree, and that therefore the government could place similar restrictions on all mineral lands, under the pretense that it was radium-bearing. That the bureaucrats' imagination is susceptible of such stretching is certain, for they have classed as forest reserves 1,814,800 acres of land in Colorado *above timber-line*.

I shall not attempt in this article to deal with the leasing question, since it is discussed in another chapter; but I should like to have the reader bear in mind that too much credit must not be given to the efficacy of proposed changes in the government of the public domain, until all sides have been heard. It will be remembered what a furore was created over the proposed radium legislation, and the average reader of the East and South could not be blamed if he believed that the miners of Colorado and other western states were actuated by selfish motives, instead of desiring merely to develop the resources of their home states.

The following facts should be borne in mind: The radium bills were shelved in committee, although they had strong backing before the Colorado miners appeared with their testimony. Bear in mind that, although a radium plant was being erected by the government in Denver before this bill was introduced nearly a year ago, no process has yet been announced, although it is claimed that announcement soon will be made. Meanwhile the government has not been in the market to buy ores, and the miners would have been compelled to suspend operations until the government plant was ready. Bear in mind that the agitation over this question caused prospectors to be filled with enthusiasm, and to search for the mineral with increased energy before the bill could be passed. Bear in mind that the radium mines of Colorado have not been operating since the European war began, because there is no American market for radium, in spite of the fact that the American manufacturers have used every effort to interest American doctors in it. If, then, there is no market here for it, if doctors will not use it, if many condemn it, how could the United States create a market or fix a price to be paid the miner?

WEST SHOULD BE HEARD

It is unfortunate that the western states have not had similar opportunity to be heard on other questions affecting their interests. Radium was a new thing, and therefore interesting. The newspapers and magazines were eager to get the whole story. Not so with other questions which lack public interest, although important to the West.

In explanation of the government's going into the radium business, its agents say they desire the radium for government

hospitals, and they will furnish five grams of radium to each hospital. There being about twenty-eight such hospitals, this would mean 140 grams of radium metal. If the government plant had a capacity of ten grams of radium metal a year, it would take fourteen years to supply these hospitals. Meanwhile, how are other hospitals and scientific institutions to be supplied?

The government-paid employes at Washington may be very good at figuring theoretic values, but they are *not* practical miners, and therefore are not in a position to judge, and we should not be made to suffer from their lack of practical knowledge.

If private enterprise has thus far furnished all the information we have on the subject, and is now producing the radium faster than the government can hope to, then let private enterprise alone, and it will work out the radium question to the satisfaction of all. Why should the government decide to go into the mining of this ore? Why not go into the mining of gold and silver, or possibly go into other forms of business? Why pick out this particular class of business? Is it because some of the government employes at Washington are desirous of becoming famous as radium investigators?

The theory has been advanced that radium is contained in all ores, and it has recently been discovered that ores of gold and silver also contain this rare element. You can therefore see that any person who locates a gold or silver mine, should the proposed law be passed, also will be subject to its provisions. In the event any miner or prospector neglects to work his claim with "due diligence" for four months each year (although he may have to suspend to seek capital), the government would have the right to go upon the property and work it. The miner, according to this plan, would receive the net proceeds from his mine, after the cost of mining and transportation had been deducted. I fear there would be no net proceeds after the government expert payroll had been paid.

HISTORY OF RADIUM

Following is a brief history of radium. Radioactive ore, known as pitchblende, was first discovered in the gold and silver mines of Gilpin County, Colorado, and its radio-activity ascertained by a French scientist, Becquerel. The element, however, was first isolated by Dr. and Madame Curie. Ore was afterwards found in old tin mines of Cornwall, England, which contained radium. Later, in the southwestern part of Colorado, carnotite was discovered, which contained, in addition to the radium, vanadium and uranium—two very useful metals. Pitchblende ore is also found at St. Joachimsthal, Bohemia. In Portugal they find autenite, a radio-active ore.

The peculiar properties of radium (which was at first exhibited as a curiosity), particularly its action on substances such as

willimite, zinc sulphide, etc., which had the effect of making them glow, caused scientists and physicians to wonder at the power of emitting rays, and to ask whether or not radium could be used to advantage in medical treatment. This aroused the interest of two noted French physicians, Drs. Wickam and Degrais, who began experimental work along medical lines, applying the radium salts to birth-marks and to various forms of malignant growths, such as tumors and cancers. The results were remarkable, and created widespread interest. Clinics were established in various hospitals, and institutes were erected for this special kind of treatment. Consequently we have the London Radium Institute, which, since its existence, has secured excellent results. The information contained in its reports is interesting and encouraging. In Berlin, which is one of the most important medical centers of the world, they have obtained good results with radium, not only in cancer treatment, but in various forms of rheumatism. They have established clinics throughout Germany for radium treatment. In Vienna the hospitals and private sanitariums are obtaining good results. The scientific and experimental work is being continually developed.

About the time Drs. Wickam and Degrais were conducting their clinic, two American doctors, seeing the work they were doing, purchased a quantity of radium to be used in America along the same lines followed by the French physicians. These American doctors obtained some very good results, but the results were never disclosed to the medical profession of this country; rather they were kept secret for some reason or other, and were not made public until Colorado commenced to produce carnotite ores in abundance, and until private enterprise, after the expenditure of \$650,000, was able to work out a successful commercial process for handling the ore. Since private enterprise began producing American radium, considerable experimental work has been conducted in this country, looking to the possibilities of the element. A radium institute has been established in Philadelphia for the treatment of various forms of cancer and arthritis, or rheumatism; a cancer commission has been established in New York and at Harvard University, and I am informed the results thus far obtained are very encouraging. In addition to this, one of the companies working the carnotite ore of our state has established in its native city a free clinic for the treatment of cancer, arthritis or rheumatism, and for the reduction of blood pressure. Marked improvements, and generally excellent results, have been obtained. They also established a pathological laboratory for animal experimentation, to ascertain the maximum and minimum dosage and further determine the efficacy of radium in other diseases.

From what I can learn, radium will play a most important part in internal medicine. In the next few years, I am informed, we shall hear of wonderful results obtained by the use of radium internally in some of the diseases that have thus far resisted medi-

cal treatment. Experiments are being conducted in the treatment of tuberculosis.

However, we must remember that radium is not a *cure-all*; it has its limitations, and those persons who, unfortunately, are victims of that dread disease, cancer, must not place too high a hope in radium, although in some forms of cancer it has given very good results. It must be borne in mind that all the results thus far obtained have been by private enterprise, or individual effort, and not under government control.

Tailings from carnotite make one of the most valuable fertilizers known to science. France has given this subject much study.

COMPANIES OPERATING IN THE PARADOX DISTRICT

The principal companies that have been operating during the past year are as follows:

The Standard Chemical Company, with head offices in Vanadium Building, Pittsburg; mining offices at Naturita, Colo.

The National Radium Company, with headquarters at Baltimore.

The General Vanadium (an English syndicate), with offices in Liverpool, England.

The Currans interests, with offices in New York.

The Colorado Carnotite Mining Company, with offices at Montrose.

The Cummings interests, Naturita, Colo.,

The Hequembourg & Talbert interests, with head offices at Denver, Colo.

There are several small, individual miners who are selling their ore wherever they can get a market. The following are the names of the principal individuals mining ore in this district: F. R. Saunders, Naturita, Colo.; Sullivan Brothers, Naturita, Colo.; Clark Akers, Naturita, Colo.; Jacob Tell, Naturita, Colo.; and a few others whose post-office address is Naturita.

CARNOTITE MINING CLAIMS IN THE PARADOX

The Standard Chemical Company is the owner of 125 mining claims: the Currans interests, of forty-five; the General Vanadium Company, of forty; the Cummings interests of forty; Frank R. Saunders, of twenty; Sullivan Brothers, of ten; Clark Akers, of ten; Hequembourg & Talbert, of twelve; Jacob Tell, of four; the Colorado Carnotite Mining Company, of fifteen. The remaining 204 claims are owned by individuals. The grade of ore mined throughout this Paradox district will average about $11\frac{1}{2}$ per cent uranium oxide and about 4 per cent vanadium oxide. The uranium oxide carries the radium, the uranium acting as a parent for the radium.

TONNAGE OF ORE MINED

There was mined from the carnotite deposits in Montrose County, during 1914, 6,000 tons of ore that would assay 2 per cent uranium oxide and 5 per cent vanadium oxide, 4,500 tons of which was mined by the Standard Chemical Company. None of this ore, in the crude state, ever finds its way into Europe, it being shipped to Pittsburg and the radium extracted at that point.

The United States government, managing the national radium property, has mined close to 500 tons. This ore is being shipped to Denver, at which point the government is carrying on experiments for the extraction of the radium, and the separating of the uranium and vanadium.

The Currans interests mined during 1914 four or five narrow-gauge carloads. Most of this ore went to Europe.

The Colorado Carnotite Company mined four or five small cars during 1914. Most of this ore also was sold in Europe.

The General Vanadium mined (principally through assessment) three small carloads. This ore was shipped to Liverpool, England.

Several small miners mined from five to ten tons of ore. About half of this was sold in Europe and the other half in New York.

MONEY SPENT IN MINING ORE IN THE PARADOX

The Standard Chemical Company has spent, for mining and transportation of ore to Placerville, \$30,000 a month. The remaining companies, combined, have spent about \$3,000 per month in the mining and transportation of ore.

DEVELOPMENT

Development work during the past year has exploded a certain theory; namely, that this carnotite ore did not extend into the ground for a distance greater than twenty feet. There are some tunnels, driven during the past year, that show large bodies of ore in the breast of the tunnel, the tunnels being driven 150 feet. Some of these large bodies have as much as 250 feet of covering on them.

MILLS

There are only two concentrating mills in Montrose County for the concentration of carnotite. The Standard Chemical Company has a large mill at the mouth of the San Miguel River, which cost \$100,000. This mill has a capacity of thirty tons in ten hours. The power to be utilized will be generated from a hydroelectric plant. It is the intention of the company to shut this mill down during severe weather and operate during a period of only about eight months, when an abundance of water can be had

from the San Miguel River, and there will be no trouble from slush, ice, etc. This mill, operating eight months, will concentrate all the ore that the company will be able to mine in the year.

The United States government has a small experimental mill in Long Park. The power to operate the mill will be a gasoline engine. At present the government has a 25-HP. gasoline engine on its property in Long Park.

FUTURE OF THE CARNOTITE MINING INDUSTRY

The Standard Chemical Company is using every effort to increase the demand for radium. The scientists throughout Europe as well as America are getting familiar with the uses for radium, and the great possibilities for radium tailings as a fertilizer will naturally create a demand for carnotite ore.

Tungsten

BOULDER COUNTY DISTRICT LARGEST PRODUCER OF THIS METAL

Boulder County produces one-seventh of the world's tungsten output and 60 per cent of the output of the United States. This rare metal had commonly been considered black iron, until its value was discovered by a prospector in 1900. Systematic mining has since been conducted and large properties have been opened. Further particulars regarding the Colorado tungsten mines will be found in this volume under the heading "Review of District No. 1" (Boulder County). A full description of tungsten—its occurrence, uses, and metallurgy—was given in the last biennial report of this department.

Tungsten is used principally in the manufacture of cutting tools, which can be made to operate four times as fast as ordinary steel without being affected by friction. It is used also in the manufacture of electric globes, electrical appliances, and laboratory equipment; but only a small quantity is needed for this purpose. It is claimed for the metal that it will eventually be used in the manufacture of steel armaments, cannon, and rifles.

Before tungsten could obtain a permanent foothold, manufacturers desired proof that the supply of ore was sufficient to warrant a redesigning of their plants. Tungsten development is still in its infancy, but sufficient has been done to warrant the statement that there is enough in sight to supply the demand for fifty years at least.

Tungsten has been discovered in Arizona, California, Idaho, New Mexico, North Dakota, and Washington; in Alaska, South Africa, Burma, the Shan States, the Federated Malay States, French Indo-China, India, Japan, Siam, New South Wales, Northern Territory, and Queensland.

It appears that manufacturers are beginning to take a sharper interest in the metal, for there was a big demand for tungsten properties in Colorado during the last six months of 1914.

The price of tungsten in the last two years has not been satisfactory, and especially in 1914.

The production of tungsten in Colorado for 1913 and 1914 was:

In 1913, 938 tons, at \$450 a ton.....	\$422,100.00
*In 1914, 825 tons, at \$300 a ton.....	247,500.00

*December not included. Based on 60 per cent product.

Gold-Dredging

By BEN STANLEY REVETT

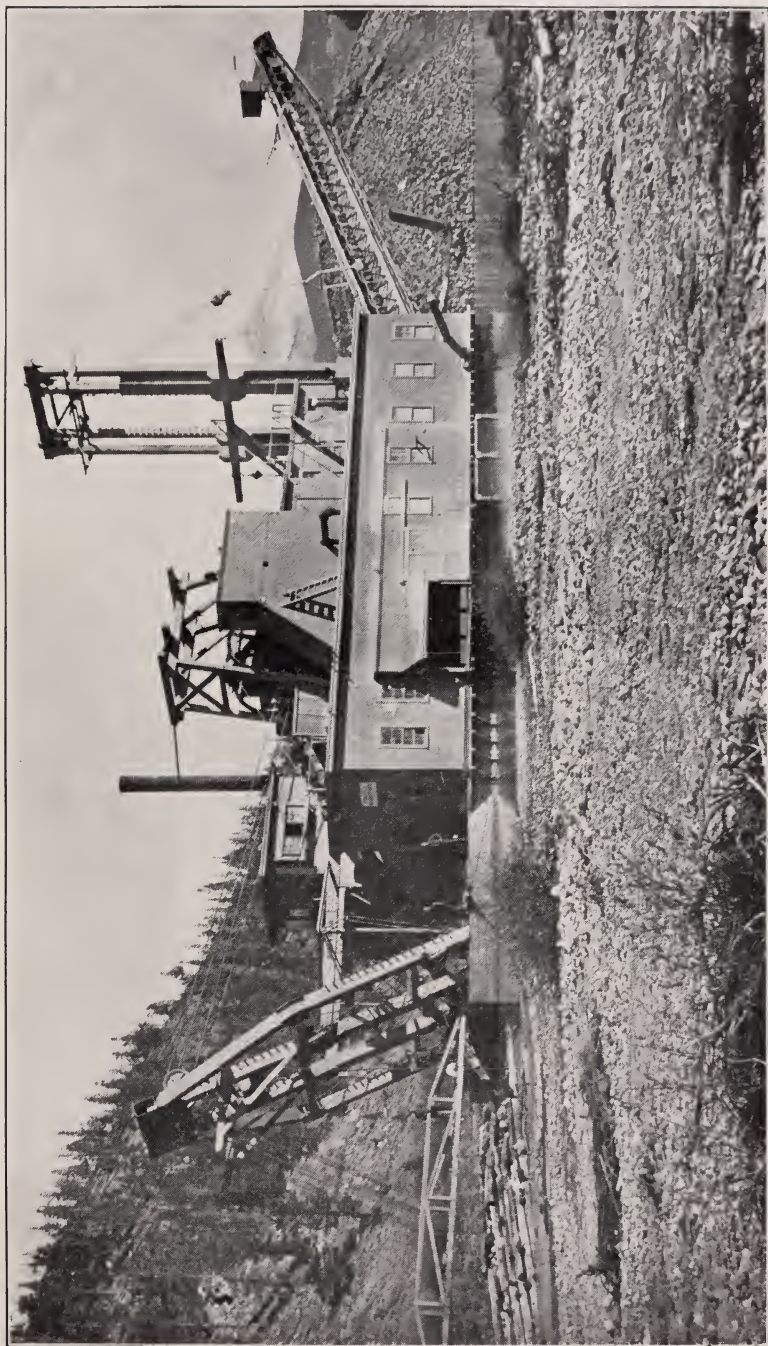
Consulting Engineer, Tonopah Placers Company

When James W. Marshall, on January 19, 1848, discovered gold at Coloma, El Dorado County, California, digging a ditch to a sawmill on Sutter Creek, he was absolutely ignorant of the nature and value of the yellow metal he had discovered. On showing it to Isaac Humphries, a Georgian who had mined gold in his native state, he was informed of the value of his discovery, making a new era in the world's history. Humphries immediately communicated with friends in his native state, the prairie schooner was manned, and thousands started for the newly discovered Mecca in the Golden West.

Reaching the Rocky Mountains, they prospected every creek, part going up the Platte River and part up the Ute Pass, investigating the present placers of Breckenridge, known as Georgia Gulch, Little Georgia, Humbug, American, French, and the Terrace Gravels of the Blue River; also the placers of Tarryall, Buckskin, and other gulches in Park County, the placers of Cache Creek, near Twin Lakes, and California Gulch in Lake County, Colorado.

Following Marshall's discovery in 1848, until 1856 El Dorado claimed a population of over 40,000. When hydraulic mining in California was at the zenith of the industry the output of placer gold, as a result of Marshall's accidental discovery, reached nearly \$80,000,000 per year. This would have continued for many years, had the anti-debris law not closed down all such operations, the detritus from these operations filling up all the navigable rivers. About this time, at the mouth of Georgia Gulch, a town was started, called Parkdale, where over 1,700 votes were polled, and where one of the first Masonic lodges and music halls in the state was built. Placer mining was carried on in the most primitive way in all these districts until 1878, when the rich silver carbonates were discovered in Leadville. The Gold Pan, Rocker, Long Tom, and Sluice were abandoned in quest of argentiferous values in Park and Summit Counties.

In 1894 patent was obtained by the writer and an associate, which started the first gold-dredging industry in the United States, the first gold bucket dredge being installed under these patent rights at Bannock, Grasshopper Gulch, Montana. In 1898 the first dredge, and the third built in the United States, was installed in the Swan River, Breckenridge District, Summit County, Colorado; followed by two others of the New Zealand



Tonopah Dredge No. 1, Summit County.

type, which were found entirely too light for even such favorable physical conditions, the dredge-builders failing to appreciate the enormous strains under which a gold dredge had to operate. At that time the largest dredge was three and one-half cubic feet to the bucket. Owing to the evolution of the industry in the past ten years, manganese steel, and improved electrical devices, the dredges of today have reached a capacity of sixteen cubic feet to the bucket, and, instead of handling a yardage of 50,000 to 60,000 cubic yards per month, are dredging and washing an average of 300,000 cubic yards, at a cost of less than 3 cents per cubic yard, and at an installation cost of \$350,000. This, as compared with the cost of equipping a hydraulic mine, is economical, as the North Bloomfield Mine in California spent \$3,000,000 in ditches, reservoirs, pipes, and monitors before turning a stream of water against the bank, with the result that they paid dividends on ground yielding 3 cents per cubic yard, which is practically what the modern dredge can do today under normal physical conditions.

Owing to the failure of the early dredges, the Breckenridge district got into disrepute and was severely criticised by men incompetent to judge it. The operations for the past few years have, however, clearly demonstrated its value as a dividend-payer, and today four dredges in this district are producing over half a million dollars per season, bringing up the yield of yellow metal from \$50,000 per year to the present yield since the dredging industry was started. The Swan River ground, which was the initial dredging property started in the district, has paid over thirteen consecutive dividends, and Dredge No. 2 of the Tonopah Placers Company shows as high an average yield as any dredge on this continent.

The record gold yields of the world have been made at the two climatic extremes; namely, on the Iditarod, near the Arctic Circle, Alaska, and on the Pato River, Colombia, within a few degrees of the Equator.

Since dredging operations have proven a pronounced success and dividend-payer to those seeking safe investments, the entire country has been pretty thoroughly scouted in quest of favorable dredging ground, and only small isolated areas can at present be found. In the State of Colorado there are several districts worthy of careful investigation. The shortness of the season, at which so many are apparently alarmed, has been exploded, as the No. 3 boat of the Tonopah Placers Company, heretofore known as the Reliance Dredge, has been successfully operated winter and summer for the past five years, at slightly increased cost during the winter months. All things being considered, the working cost in the Breckenridge District compares most favorably with the average conditions in California, which vary from $2\frac{1}{2}$ to 7 cents per yard, according to the size of the dredge and local conditions. Every district is a law unto itself. The only districts that average up uniformly are the Yuba and the Feather Rivers, both of which

are of fluvial origin. In the Folsom district some of the dredges are working under easy conditions and others under very severe ones. In the Breckenridge district conditions vary on different streams and in different portions of the streams. On French Gulch the ground has always been compact and the banks would not cave. On the upper end of the Tonopah property, on French Gulch, a vein system crosses the ground diagonally northeast and southwest, and the dredge at that point encountered the hardest digging ever coped with in any district. On the Swan River the ground caves so readily that it is hard to keep a gang plank in place long enough to reach the bank. On the Blue River the deposit is of a lacustrine (lake-bed) origin, and is easily excavated and washed, which is fortunate, the values being of very much lower tenor than the other deposits, requiring a dredge of large capacity to reduce working costs.

The derivative source of the auriferous deposits in the Breckenridge district has been determined beyond peradventure, and the volume and workable areas are well known, as nature's gulches are sluice-boxes which readily show their origin, content, and extent to the experienced examining engineer, and do not require the exhaustive drill-prospecting of large, wide areas.

The greatest drawback in the dredging industry—in fact, in the mining industries of Colorado—is the excessive cost of electrical power. In the California districts, which are more favorable climatically for power transmission, the dredging cost varies from one-half to one cent per kilowatt hour, and the average cost per dredge per month in the Oroville district is about \$900 to \$1,000, and about \$750 per month per dredge in the Natoma and Yuba districts. About 90,000 K.W. power per month per dredge is used in the Oroville district, against about 100,000 K.W. in the Natoma and Yuba districts. The power bills per month, even on the fifteen- and sixteen-cubic-foot boats, average only \$1,100 to \$1,800. In the Breckenridge district we unfortunately have to pay 1.37½ cents per K.W. to one company, and 1.65 cents per K.W. to another, our power bills for the three dredges running from \$2,000 to as high as \$2,500 per month, being in nearly every instance as much as the cost of the labor employed.

The possibilities of exploitation and further development in several districts in Colorado are worthy of investigation and serious thought, as the state of the arts and dredging industry is now such that ground can be worked at a profit at the present time that could not be considered even five years ago, as the writer knows to his sorrow; for had the present up-to-date dredges been in vogue fifteen years ago, he would have had an annual income of \$40,000 per year in dividends from the Breckenridge district. As in all pioneering, however, he had to pay to gain his experience.

At the present time there are no unknown quantities in the dredging industry that cannot be determined by an experienced,

competent gold-dredging engineer. Gold-dredging can safely be regarded as an industrial, rather than as a speculative, proposition; and to some it may, therefore, not be so attractive as other kinds of metal-mining.

Precious Stones and Gems

By J. D. ENDICOTT

In this article I shall endeavor to give a review of operations conducted in Colorado in the production of gems and precious stones during the years 1913 and 1914. Mining for gem materials is conducted on a plan different from that of metal mining. The workings are shallow, and consequently a large number of workmen is not required.

The gems are used for various purposes, but principally as jewelry, ornaments, and for cutting. Europe has been the principal market in the past, but the American market is rapidly increasing. Some of the gems are in demand by tourists visiting the state, and scores of establishments in Colorado make a specialty of this business.

AMAZONITE

From 1908 to 1912, 2,600 pounds of amazonite were mined in Colorado and shipped to Europe. During 1913 and 1914 the output was 600 pounds, most of which was sold in the United States. Amazonite in Colorado occurs in pockets which have no connection with one another, so that the miner must be able to detect surface indications. The principal deposit is four miles north of Florissant. In mining amazonite, I usually work with two assistants. Amazonite is marketed as a gem and ornamental stone. The market price varies from 50 cents to \$2.50 a pound, depending upon the quality and market conditions. The war has destroyed the European market for this material, but the prices are rapidly advancing in the United States.

AMETHYST

There is a good deposit of this material thirteen miles northwest of Canon City, where prior to 1912 I mined 400 pounds of fine quality, for which I found a ready market in New York at \$1.25 a pound. The stone is used in several kinds of cutting. The operations were conducted by myself and one man, but we have not worked this property for two years.

AGATE

During the years 1913 and 1914 we mined (gathered) 1,150 pounds of agate of different classes and grades. The deposits are scattered over a large territory in Fremont, Park, Pueblo, and

Huerfano Counties. A deposit near the I. M. Ranch on Badger Creek, Fremont County, is capable of producing a large quantity of very excellent moss agate. Many of the pieces are of rare beauty and are valued according to their markings, which is true of all ornamental agates. The price may vary from 50 cents a pound to \$50 an ounce. The most valuable species of agate is the St. Stephens stone, found in Garden Park, eight miles north of Canon City. These are the chalcedonic concretions in the bone of the dinosaur, and are consequently rare. Only a small percentage of the stones found are of the best quality, which accounts for their value.

CHALCEDONY AND JASPER

From a commercial standpoint, the only difference between chalcedony and jasper is the color, and therefore they are mentioned under the same heading in this article. A few of them are cut for gems, but they are used mostly for mechanical purposes. The material is used for making handles for dental and surgical instruments, and for toilet articles; for bearings for weighing-scales, and other similar purposes. It ranges in value from 10 to 50 cents a pound, depending upon the size and quality. Chalcedony and jasper are found on the surface of the ground, scattered here and there in isolated places. They are mined principally in the northwestern part of Fremont County and in South Park. We have orders from five firms for ton lots of this material. We mined 1,200 pounds in 1914.

ROSE QUARTZ

There are two deposits of rose quartz in Colorado—one about twenty-five miles north of Boulder, and the other twenty-six miles west of Canon City. The Boulder County deposit was located by Mr. W. C. Hart, of Manitou. It appears to contain a fairly good quality of material, but no recent production has been reported. The Fremont County deposit, west of Canon City, is operated occasionally by Endicott and Davis. A large quantity of it is too pale for gems, but it would be a most beautiful material for the construction of fancy residences. There is enough material in sight for several such houses. We mined 365 pounds of high grade during 1913 and 1914, mostly for our own use. We shipped some to Europe and some to various parts of the United States. It is used commercially for cutting. The material ranges in price from 10 cents to \$12 a pound.

QUARTZ

(Smoky and Clear Crystal)

Deposits of this material are found in the foothills near Pikes Peak and in northwestern Teller County, near Florissant. Mr. A. B. Whitmore and his associates produce considerable quantities of smoky topaz, suitable for gems and specimens. The

production for 1913 and 1914 was 600 pounds. Smoky quartz of gem quality is worth from 50 cents to \$2.50 a pound. The clear quartz crystals are less plentiful, and little has been mined in recent years.

SARDIUS

This gem is of rare occurrence, being found only at Curio Hill, seven miles southeast of Canon City. Douglass B. Sterrett, of the United States Geological Survey, and I visited this district in 1912 and found about five pounds of the material. It is worth \$4 a pound.

TOPAZ—PRECIOUS

Precious topaz occurs near Florissant and in Ruby Mountain, near Nathrop, Colorado. There are other places where it occurs, but with present developments I do not consider it of much importance. The production of the material has been only a few pounds in the last ten years. The quality is fine, and the cut gems are exceedingly brilliant. I consider the Florissant locality capable of production in appreciable quantities, in colors of pale blue, pale yellow, and colorless. The Nathrop locality produces small crystals in golden and pale yellow. I found one stone, of a beautiful bright pink, that weighed, when cut, 1.65 carats. This was the only pink stone found not exposed to the sun. The value of the Colorado precious topaz is greater than that of other localities, on account of its rare beauty, and will bring several dollars an ounce.

GARNET

The almandine, or precious garnet, is found in several places in Colorado, but the most prolific source is two and one-half miles southwest of Canon City. We find it in considerable quantity and of excellent quality, but the stones are small; the largest one yet found weighed, when cut, 2.25 carats. There was no production in 1912-1913-1914. The value is \$35 a pound, mine-run.

EPIDOTE

The variety of epidote used for gems, found in this state, is a compact material which comes in seams in coarse granite. It is also found in pebble form in the wash of the foothills near Canon City. Cut cabachon, it makes a very pleasing stone and retains a polish. The production for 1912 and 1913 was about 200 pounds, which was sold in Germany for 50 cents a pound.

AQUAMARINE

This very beautiful gem is found at Mount Antero, and also twenty-five miles southeast of Silverton. Up to 1912 we produced twenty-six pounds; since that time the production has been about three pounds. A good grade of aquamarine is worth from \$45 to \$95 an ounce.

Mica Mining and Milling

NEW COMPANY DEVELOPING PECULIAR SPECIES IN CHAFFEE COUNTY

Mica is liberally distributed over Colorado. Every stream in the state bears evidence of the abundance of it; for it appears in fine particles mixed with sand. In many canons, where the strata have been laid bare, the mica is seen in place, but it is seldom of sufficient abundance or quality to justify development. Only a few deposits have been worked. Scrap mica for grinding is found in large quantities in Fremont County, near Canon City, and in Mesa County, near Grand Junction; but better wagon-roads are necessary before development can be perfected. Sheet mica of good quality has been discovered in the Bare Hills, Fremont County. Another large deposit has been found in Jefferson County, near Conifer. This also is far removed from a railroad, on a mountain wagon-road.

The principal operations in the mica industry are being conducted by the Denver Mining and Manufacturing Company, recently organized by Denver capitalists to develop a peculiar species of this mineral found in the Turret Mountain mining district, Chaffee County, in true fissure veins, the Star and Gold Leaf.

The Star and Gold Leaf are two full, unpatented, lode-mining claims, end-lining, and comprising about forty acres. These claims are located about twenty miles southeast of Buena Vista, about fourteen miles north of Salida, and about five miles southeast of Hecla, all stations on the main line of the Denver and Rio Grande Railroad. The workings are about one mile southeast of the mining camp of Turret and one-half mile south of a camp generally known as Klondyke, at an elevation of approximately 9,000 feet. Good wagon-roads connect with outside points. Mining can be conducted the year around with comfort, since the snowfall is comparatively light. Water is available near by, and the cost of supplies is reasonable.

The discovery shaft on the Star lode claim is located about 400 feet east of its west end-line. It was sunk on a true fissure vein about 4 feet wide, having an easterly and westerly course, with a slight dip to the south. The Star vein is intersected about 200 feet east of the discovery shaft by a fissure 2 feet wide, having a course northeast and southwest, known as the Austin vein.

The discovery shaft on the Gold Leaf lode claim is located about 125 feet east of its west end-line. It was sunk on a true

fissure vein about 3 feet wide, having an easterly and westerly course, with a slight dip to the south. The Gold Leaf vein is believed to be a parallel fissure to the Star vein, since it was opened in the Star claim about 150 feet north of the Star discovery shaft, and answers the description of the Gold Leaf vein where it was exposed.

The Star discovery shaft was sunk to a depth of 12 feet, and the vein further exposed by a series of trenches, pits, and other surface openings to a point about 800 feet east of the discovery. A shaft forty feet deep was sunk fifty feet east of the discovery, and an open-cut has been driven commencing at a point sixty feet west of the discovery, where the hill breaks sharply to a gulch about 400 feet below the point on the ridge where the discovery shaft was sunk. This open cut has been driven over 100 feet through the discovery and 40-foot shafts, and is taking out the vein matter clean to the surface to a depth of about 30 feet, producing the mineral now being shipped to the mill.

The Austin vein has been opened by a 25-foot shaft at a point about 175 feet southwest of its intersection with the Star vein. It will be further prospected by an opening now being made by a cross-cut tunnel whose heading is north of the Star vein and is designed to cut it at a depth of about 40 feet at a point 200 feet east of the discovery shaft.

The Gold Leaf discovery shaft is 11 feet deep, and a shaft has been sunk 50 feet east of it to a depth of 35 feet, where drifting is in progress both ways on the vein. Ore-bins have been constructed at this shaft, at the open cut on the Star vein, and at the portal of the cross-cut tunnel. The work done so far is largely of a prospecting nature, but the mineral is all of commercial value between walls, and is accordingly being saved for shipments, which are now under way.

GEOLOGY

These veins are in granite formation, their mineral content being a biotite mica of the vermiculate family. The foot-wall is a fine-grained, altered, gray granite. The hanging-wall is a hard black schist. The solid mica occurs similar to an ore-shoot in metalliferous veins, being wide in places and narrow in others; at times pinching out entirely. These shoots appear more or less as lenses, having a general length of about 40 feet and a depth of 30 feet. The remainder of the vein-filling is a soft, black schist, carrying about 50 per cent of mica in small flakes, whose characteristics are identical with the solid mica. Intrusions of quartz occur in the solid mica at irregular intervals in small, crystalline shapes, with the mica books closely cemented to the smooth sides of the crystalline faces. The mica adheres to the smooth surface of the footwall similarly.

MINERALOGY

The mica found in these veins possesses peculiar properties rarely observed, so far as can be learned from authorities consulted. Its appearance, when taken from the ground, is similar to the ordinary biotites, or black micas; but there the similarity ceases. The nearest classification is by Dana, which covers but one point of its peculiarity; i. e., its expansion when exposed to a high temperature. This authority gives it the name of "vermiculite," a variety of jefferisite, but does not describe the change in color to a golden bronze.

The Star mica strips in leathery strings, instead of thin, flat flakes, as do the other biotites. These leathery strings are opaque, of a dark-brown shade, not unlike the color of thin rubber sheets when held to the light. This mica exhibits its greatest peculiarity when exposed to heat. If placed in the muffle of an assayer's furnace having a temperature of 1,200 degrees or more, it immediately begins to expand along the lines of its laminations. Within ten minutes it will have swollen from eighteen to twenty times its original thickness. Its greatest transformation, perhaps, occurs in its change of color. With the process of expansion, the heavy, dark, brownish-black mass becomes a light, fluffy ball of a bright, golden color. When ground to fine powder (160 mesh or smaller), it has all the characteristics of a high-class bronze powder, excepting the weight. Coarser grinding gives bright, golden flakes, toning to a Roman-gold effect. Microscopic examination shows each sheet or lamina has separated from its fellow, and the gold color is an even tinge throughout its entire cleavage. Micrometer tests prove these minute sheets to be perfectly uniform in thickness.

ANALYSIS

Analysis of this mica gave the following percentages of constituents: silica, 35.80; alumina, 19.00; iron oxide, 16.50; magnesia, 13.95; alkalis, 6.85; lime, .95; loss on ignition, 6.95.

The reaction by heat quickly takes place, and longer exposure to a higher temperature causes no further reaction of any kind. Nor is the color changed by fumes, acids, or chemicals of any nature so far discovered. The mica flakes retain their golden appearance, luster, and permanence under all conditions of test that could be suggested by competent chemists to date.

An unexplained phenomenon is that, if heated in the open air, the expanded mass becomes metallic silver in color; but, if roasted in the absence of oxygen, its color is golden.

The chief difference in analysis from other micas is in the alumina contents, this mica having from four to five times as much of that element as the average content given for other biotites.

The Denver Mining and Manufacturing Company has taken a lease on a mica mill for treatment of the product. The roasted

and ground output of this mill has been given the trade name of "tung-ash," it being an abbreviation of "tungeson ash" and "tungstic ash," by which names a material similar to this biotite is said to be known to the trade of Europe. The foreign article is reported to have been mined for generations by one family at a point near Carlsbad, Germany, but the deposit is now practically exhausted.

Tung-ash in 10 and 20 meshes is in demand for surfacing hydrocarbon or prepared roofings. It makes an indestructible golden surface of rare beauty for either outside or inside decoration on any flexible material.

Tung-ash in 40 and 60 meshes has proven to be the best binder known in the manufacture of composition wares of high-grade plastic material. Various combinations of tung-ash, silica, calcined magnesite, and chloride of magnesia are used to reproduce in better colors and more durable form any article that can be made of clay, terra-cotta, plaster of Paris, etc.

Tung-ash in 80 and 100 meshes will enter largely into the manufacture of rubber goods. As a filler in the reduction of crude rubber to commercial form it probably will supersede ground soapstone and other silicious earths now used. It is superior as a decorative element in the manufacture of rubber tiles, mattings, and other floor coverings. As a lubricant between inner tubes and casings of pneumatic tires it is unequaled, as demonstrated by the largest rubber-goods manufacturing company in America. Tung-ash is a non-conductor of heat and electricity; sheets are perfectly uniform in thickness; it is absolutely free from grit and contains a non-carbon oil; all of which make it an ideal lubricant, either dry or in combination with greases or other materials of a suitable nature.

Tung-ash in meshes smaller than 100 will be used as an "extender" in bronze powders for various decorative purposes, particularly wall-paper. It being unaffected by acids or alkalis, it preserves its color under all conditions; yet it is readily colored by aniline dyes to any shade desired, still preserving its metallic sheen and luster. The true nature of this material is not thoroughly understood; hence its further value commercially will probably be enlarged and increased by future experiments.

MILLING

The general treatment of this biotite is much the same as that used to make ground products of other micas. Hence a well-equipped mica mill erected at Sixteenth and Bryant Streets, Denver, was leased for the production of tung-ash. A suitable roaster was designed and installed, using a residuum oil for fuel through a Case burner. The treatment process, briefly stated, is as follows: Crude mica is fed to a mica beater, or grinder, and discharged through a half-inch screen on a belt conveyor which unloads in a feed-bin over the roaster. From this feed-bin the

crude is automatically fed to a roaster, which consists of a rotating drum 25 feet in length and 12 inches in diameter, heated to 1,200 degrees at the lower or discharge end. The material requires about eight minutes to traverse the roaster from feed to discharge ends, it being dropped fully expanded and colored on a quarter-inch screen. The over-size from this screen is carried by a screw conveyor to feed-bins over the secondary grinder, where it is automatically fed and discharged through a 12-mesh screen to a bucket conveyor which delivers it to the feed-bins over the bolters. The under-size from the roaster is discharged to the bolter feed-bins direct by an air current of sufficient strength to carry only the light mica and allow the silica to settle into a trap where it can be dumped when necessary. The bolters deliver 12, 20, 40, 60, 80, 100, and smaller, to separate bins with sack discharges, where packing for shipment is conducted. At this point a man is required; another feeds the crude to the preliminary grinder; and a third exercises general supervision over all. The power being electric and the mill automatic, a considerable daily tonnage can be handled at a minimum expense.

The Salida Monumental Granite Industry

About eight years ago, while prospecting for minerals in the Cameron Mountain district, about twelve miles northeast of Salida, immense deposits of the finest monumental granite known to the trade were discovered.

After a thorough investigation of the quality, quantity, and market for this product, a company was organized, composed of Salida citizens. This company, known as the Salida Granite Company, has been in successful operation since then, marketing its product east and west, and has been compelled to enlarge its manufacturing plant several times.

The present production from this new field has proven quite a revenue for the town of Salida, where the Salida Granite Company's finishing plant is located, and for the Denver & Rio Grande Railroad, which has no competition at this point.

Since the early discovery of this granite, made upon property owned by the Colorado Fuel and Iron Company, other deposits have been found, notably that of the Federal Consolidated Monumental Granite Company, also composed of Salida citizens, which owns 480 acres of granite in one solid block, and is now engaged in the erection of a large manufacturing plant at the quarry, thus avoiding any waste haul and giving it the best economic location possible.

This company has built roads, telephone lines, etc., to its quarry, and is now erecting a modern manufacturing plant. Large quantities of the granite have been marketed in the rough. The quality of the stone is so satisfactory that many orders have been received from various large eastern and western wholesale jobbers.

The industry is located close to the railroad, and branch lines are being planned connecting with the Denver & Rio Grande Railroad, thus obviating the present wagon haul.

The granite field is located at distances varying from eight to twelve miles from Salida, and has the best climatic conditions. An abundance of timber and water is available. The elevation of the quarry ranges from 7,500 to 8,500 feet, while that of Salida, the shipping point, is 7,000 feet, so that the haul is all down-grade.

These large deposits are found in ledge and boulder formation, and cover a large area. The deposits present a most favorable condition for economic quarrying, inasmuch as they stand in

mountains above the gulch or valley levels, whereas the quarries of the eastern states are in open pits.

Much development work has been done upon the deposits of the Federal Consolidated Monumental Granite Company, consisting of numerous quarry openings, prospecting tunnels, and shafts. The depth of the deposit has been proven to 400 feet. However, sufficient prospective development work has been accomplished to establish that the deposits are practically inexhaustible.

The granite consists of light and dark-blue colors, takes a beautiful high polish, and shows a remarkable contrast in lettered or hammered work, these being two salient points. Its wonderful compressive strength is as great as that of any stone product.

The operators in the field have acted wisely in first fully prospecting their deposit, ascertaining the cost of quarrying and possible market. There are but three companies operating—the Salida Granite Company, the Federal Consolidated Monumental Granite Company, and the Stratton Granite Company; but there are sufficient deposits, demand, and market either for a larger production by these companies or for other operators to enter the field.

Favorable freight rates are in effect, permitting this granite to enter into competition throughout the entire country, and as fast as capital is secured the market is being extended.

The following is a report made by the University of Colorado on Salida granite: compressive strength, 25,550 pounds to the square inch; modulus of rupture, 4,345 pounds to the square inch; proper specific gravity, 2.83; ratio of absorption, .27 per cent; porosity, .76 per cent; coefficient of wear, 14.54; modulus of elasticity, 1,103,200 pounds to the square inch.

The granite industry of this field will be of vast benefit to the entire state. Government statistics show that the production of manufactured or monumental granite in the United States in 1913 was \$29,733,000, an increase over previous years. This production was made practically from the granite in the fields of Barre, Vt.; Westerly, R. I.; Quincy, Mass., and in fields of several southern and eastern states, but practically all of it east of Chicago. Thus the Salida product has a wide field awaiting it.

The Federal Consolidated Monumental Granite Company has installed modern steam derricks for air drills upon its quarry, and has imported experienced granite-workers from the East. The Salida deposit, being so immense and excellent in quality, assures a permanent and profitable industry.

Quarries of The Colorado-Yule Marble Company

By J. F. MANNING, President and General Manager

DEPOSIT

The Colorado-Yule Marble Company's property, located on Yule Creek, Gunnison County, Colorado, on the western slope of the Rocky Mountains, forty miles south from Glenwood Springs, contains the most extensive white-marble deposit in the known world. Where the Colorado-Yule Marble Company has opened the marble quarries, a cross-section of the deposit is exposed for more than 4,000 feet, running north and south, on the west side of Yule Creek canon, and shows a thickness of over 300 feet. The dip of the deposit is to the west and runs to an unknown depth. It is obvious, therefore, that the supply is inexhaustible.

There is also a vast deposit of colored marbles underlying the white marble, the thickness of which deposit is about 125 feet; the colors ranging from greens, grays, and blues to almost black. These colored marbles have not yet been developed for commercial purposes.

HISTORY OF THE COMPANY

The Colorado-Yule Marble Company was promoted by Colonel C. F. Meek in the summer of 1905. There was little development work done of a permanent nature the first year. Since 1906 the marble deposit has been thoroughly developed, and the four quarries now being operated are fully equipped with all the latest quarry machinery—derricks, cable-ways, etc. The working floor space is 50,000 square feet, with a capacity of a monthly output of 60,000 cubic feet.

MILLS AND MANUFACTURING PLANT

The mills and manufacturing plant are located at Marble, three and one-half miles from the quarries, and consist of four complete finishing shops, two sawing plants, with rubbing-beds, planers, diamond saws, and carborundum machines, the equipment of which is the best and most complete of any marble plant in the world. The plant has a capacity of turning out 50,000 cubic feet of stock per month.

POWER PLANT

The hydro-electric power plant consists of two units, which generate 1,750 HP., which is supplied by water from Crystal



Quarry Scene, Colorado-Yule Marble Co., Marble, Colo.

River, Yule Creek, and Lost Trail Creek, through about 13,000 feet of steel-riveted pipe. The company also has a steam turbine plant, which generates 500 HP. to supply any deficiency of power during extremely cold weather.

TRANSPORTATION

The quarries are connected with the mill by an electric trolley railroad, three and one-half miles long, with two complete trains, having a capacity of delivering from the quarries to the mills 100,000 cubic feet of marble blocks per month.

A steam railroad, eight miles long, connects the town of Marble with trunk lines. This railroad performs daily service except on Sunday.

MARBLE

The product of the company has been used in a large number of important buildings since the quarries have been developed and the marble placed on the market; notably, the Cuyahoga County Court-House, Cleveland, Ohio; the Mahoning County Court-House, Youngstown, Ohio; New York City Municipal Building; United States Post-Office, Denver, Colo.; City Hall, San Francisco, Cal.; Lincoln Memorial, Washington, D. C.; and numerous other public and private buildings throughout the United States.

EXPERT OPINION

The Fine Arts Commission, when called upon by the Secretary of War for a report on the merits of Colorado-Yule marble for the Lincoln Memorial building at Washington, D. C., reported, in part, as follows:

"The artistic qualities of Colorado-Yule marble as compared with the others submitted, in the opinion of the commission of Fine Arts, fit it pre-eminently for a structure of the character of the Lincoln Memorial.

(Signed) DANIEL C. FRENCH,
Chairman."

Dr. George P. Merrill, head curator of geology at the Smithsonian Institution, Washington, D. C., who has just completed a thorough examination of the entire marble deposit, reports, in part, as follows:

"I am very agreeably surprised at the extent of the marble beds here and their development. I regard the stone as of a very high grade and of exceptional beauty. It is remarkable for its translucency and for its clear white tones. In this respect it is not excelled by any white marble in America, and I can recall none of the foreign deposits which excel it."

Ex-President William Howard Taft, chairman of the Lincoln Memorial Commission, in writing to Senator John F. Shafroth, of Colorado, said:

"I am very certain that Colorado marble is far and away the most beautiful marble that was presented to us for the Lincoln Memorial. The artistic idea in the Lincoln Memorial is that of a shrine of classic beauty and purity. Nothing will carry this idea so certainly in the outward appearance of the Memorial as the limpid purity and whiteness of the material of which it is to be constructed. No one, whether layman or professional architect, or expert stoneman, can look at the samples of the various marbles which were proposed to us and be for the slightest moment in doubt as to that which is whitest and purest and best adapted to the purpose."

The reports of the experts, together with the inexhaustible supply of Colorado-Yule white marble, will unquestionably bring not only a yearly increased demand for Colorado's pre-eminently best marble, but with it a wide advertisement for the State of Colorado, which will furnish both exterior and interior material for the best monumental and public buildings throughout the United States. The more prominent architects of the country are making it the standard of quality in their specifications, and nearly every city of importance in this country has an example of Colorado-Yule marble in some of the structures which have been erected within the past five years.

Turkey Creek Sandstone

Pueblo or "Turkey Creek sandstone" is found at Stone City, a Colorado common point twenty-two miles northwest of Pueblo, at the terminus of the Colorado-Kansas Railway.

The stone covers an area of about 500 acres. The various ledges are from fifteen to forty feet in thickness. The quarries are equipped with electrically operated machinery, with a capacity for handling thirty-ton blocks.

The saw-mills are equipped with seven gang saws, one diamond saw, three planers, rubbing-bed, and lathes, all of which are served by a twenty-five-ton electric traveler. One hundred men are required to operate the quarries to their full capacity.

The stone is found in six distinct colors, viz: gray-veined, white, flesh tint, gray, turkey egg, and pink. The stone has been used in the Pueblo County Court-House; Denver Public Library; Wichita Union Depot; Bartlesville (Okla.) Court-House; United States Post-Office, Ottawa, Kan.; Penn Valley Natatorium, Kansas City, Mo., and many other noted buildings. This stone is of unusually close texture, and without doubt possesses the most delicate coloring, which combined with its exceptional crushing strength (12,850 pounds per square inch), makes it the most desirable stone found in America.

Other Colorado Stone Resources

Colorado has many large deposits of granite, limestone, sandstone, and lava rock awaiting development.

The beautiful marble used in the interior decorations of the Colorado State Capitol was obtained in a quarry in Pueblo County, near Beulah. The granite used in the superstructure of the State Capitol was quarried in Gunnison County, where a large area awaits development. Granite also is quarried at Platte Canon, Silver Plume, Cotopaxi, and Arkins.

The St. Vrain country, near Fort Collins, produces a superior quality of red sandstone. Large deposits of sandstone also are located near Howard and Morrison, and along Turkey Creek and Texas Creek. Considerable lava is quarried at Del Norte and Castle Rock.

Limestone occurs abundantly in many parts of the state.

Gunnison County contains a deposit of grindstone superior to that of any eastern state.

Cement Industry in Colorado

Since our twelfth report, in which we published an article on the cement industry, that business has continued to produce about the same amount each year. The plants are located near Florence, in Fremont County, where requisite rocks are properly proportioned in close proximity.

The rock used by the Portland Cement Companies lies on the surface in horizontal strata, considerably above the cement plants and very close to them. The shale, the principal material used, is very loose, and is handled with ease by the large 70-C Bucyrus and thirty-six Marion steam shovels; and the limestone is easily broken up into suitable size for steam-shovel loading. The steam shovels load the rock into four yard dump cars, which deliver to the No. 10 McCully and No. 6 Gates gyratory crushers.

This rock has the correct chemical proportions to make the highest quality of cement. This fact, together with the great advantage of the ease and economy of handling the rock from the quarry to the cars by the steam shovels, the low rates of freight to all Rocky Mountain points, and the ability to work every day in the year on account of warm winters and little snow, originally located the cement industry at this place.

The section is also well supplied with gypsum, which is a small, but important, factor in the manufacture of Portland cement.

One feature of this business is the wonderfully accurate system of controlling the chemical proportions of finished cement. The laboratory and corps of chemists are of the greatest importance. The rock in the quarry is carefully sampled and analyzed ahead of the steam shovels; again, when crushed and weighed; again, when burned and ground; and again, when ready for shipment. In other words, no expense or trouble is spared to make trebly sure that the cement is perfectly uniform.

The system of handling thousands of tons through huge bins by various mixing devices necessarily and mechanically avoids whatever variation there could have been at the start, and each carload is as nearly the same as every other carload as science can make it. Perfect uniformity is considered in every respect the first and last requisite in the manufacture of the Colorado cement.

The development of the cement production in the United States has been very rapid. Wherever lime and clay were found—and that means in almost every country—some “progressive” man discovered that he had a “gold mine,” “the best material in



Colorado Portland Cement Co.'s Plant, at Portland, Colo.
(Showing Workmen's Homes.)



Colorado Portland Cement Co.'s Plant at Portland, Colo.
(Nearer View of Plant.)

the world with which to make Portland cement," and immediately proceeded to promote a cement company. The history of the financial side of the business is a succession of disasters. Although the demand for and the production of cement have increased to 100,000,000 barrels per year, the open competition that has always prevailed has been serious to the investor.

Cement is being shipped from Colorado to western Kansas and Nebraska; to South Dakota, Wyoming, Utah, Arizona, and New Mexico; besides supplying all that has been used in Colorado. Formerly Colorado shipped cement into Canada and Mexico, and to every state west of the Missouri River; but the building of one or two plants in every state has greatly abridged Colorado's territory, and new factories about completed will soon materially reduce the present territory and tonnage.

Some recent improvements in rock-handling machinery have been installed in the Colorado plants, displacing previous apparatus. Some \$300,000 has been spent in new power and other machinery, and every possible improvement and cost-reducing apparatus installed, regardless of cost.

The natural result of the policy of the Colorado cement manufacturers of keeping right up to date in regard to equipment, processes, and organization has gradually put them in a position where they are able to manufacture a product of the highest standard and uniformity, which will equal in every test Portland cement made in any other state of the Union. The improvements in plants and equipment, coupled with the natural advantages enjoyed on account of the favorable climatic conditions in the Arkansas Valley, where these plants are located, have made it possible for these companies to pay the high Colorado wages and expenses, yet to compete in the Colorado market with any brand of cement from other states at reasonable prices to the consumers.

It may be interesting to note the amount (in pounds and tons) of material handled by the two Colorado plants in the course of a year's operation (300 days); 480,000,000 pounds, or 240,000 tons, of rock are handled by the steam shovels, from quarry to crusher, from crusher to rock storage bins, from bins to driers, from driers to raw mills, from raw mills to kilns, from kilns to clinker storage, from clinker pile to the preliminary finish grinding machinery, thence to the finishing tube-mills, then to the cement storage bins, and finally into sacks and loaded on cars; 150,000,000 pounds, or 75,000 tons, of coal are used in the burning of this cement; large power plants are required to furnish the electric power (approximately 7,500 HP.), for each machine is electrically driven.

Large and complete machine shops are maintained at each plant, and both companies have made it a rule to buy everything possible from Colorado merchants and manufacturers.

OUTPUT

In 1913, 731,000 barrels, at \$1.30	\$950,300
*In 1914, 760,000 barrels, at \$1.05	798,000

*Output for December not included.

MEN EMPLOYED

In 1913, 213 men; in 1914, 215 men.

Clays

Although Colorado contains rich deposits of various kinds of clays, there are only three classes of clay manufacture in the state: the brick and tile, pottery, and medicinal. The medicinal clay, from which Antiphlogistine and Denver Mud are manufactured, is obtained near Golden, in Jefferson County. It occurs in fissure veins. This clay also is used in brick and tile manufacture.

There are several pottery works in Colorado, including those of Golden, Denver, and Colorado Springs, which manufacture a superior grade of utensils and ornaments.

There are brick kilns in nearly all counties of the state, which obtain a supply of clay from local beds. The two largest plants in Colorado are the Denver Sewer Pipe and Clay Company, of Denver, and the Standard Fire Brick Company, of Pueblo. These plants manufacture fire brick, vitrified brick and building-brick, sewer pipe, fire-clay lining, and drain tile.

Colorado finds a market for its clay products in New Mexico, Wyoming, Montana, South Dakota, Nebraska, and Kansas. The railroads operating between the Missouri River and Colorado use a large quantity of drain and sewer pipe manufactured in this state.

There are 3,500 men employed in the clay industry in Colorado.

Asphalt--Gilsonite

Mr. W. W. Wilson, of Baggs, Wyo., has located two beds of asphalt in Moffat County. One bed is 600 feet long and thirty feet wide. There are six places in this deposit where asphalt outcrops appear. It is of an excellent grade for street-paving.

The other deposit is gilsonite and comes up through a light-brown shale. The color resembles that of sulphur. On the lower part of this seam there is a shale almost as black as asphalt.

Mr. Wilson drove a tunnel seventy feet into the first-named bed, and has done a little prospecting on the other bed.

Grahamite is found in Grand County, on Willow Creek. This deposit was being developed until a few months ago. The expense of the long wagon haul to Granby made mining unprofitable.

A deposit was found north of Rifle, in Garfield County, consisting of maltha and gilsonite, but it is not of so high grade as the product found in Utah.

Another vein was discovered in Sinbad Valley, in Mesa County, close to the Montrose county line and near the Colorado-Utah state line. This has not been developed.

Acid Manufacture

BY-PRODUCTS OF LOW-GRADE SULPHIDE ORES CREATE IMPORTANT INDUSTRY

The manufacture of by-products of low-grade sulphide ores has become an important branch of the metal-mining industry of Colorado. The Western Chemical Manufacturing Company, whose plant is located in Denver, treats 40,000 to 50,000 tons of low-grade zinc-lead-iron sulphide ores annually from Leadville, Rico, Georgetown, Breckenridge, and Kokomo. A beginning was made in a small way in 1881, and the plant has now grown to an institution which has an annual output of \$800,000 and employs 175 to 200 men. The plant covers fifty acres in South Denver, of which twenty acres are devoted to buildings.

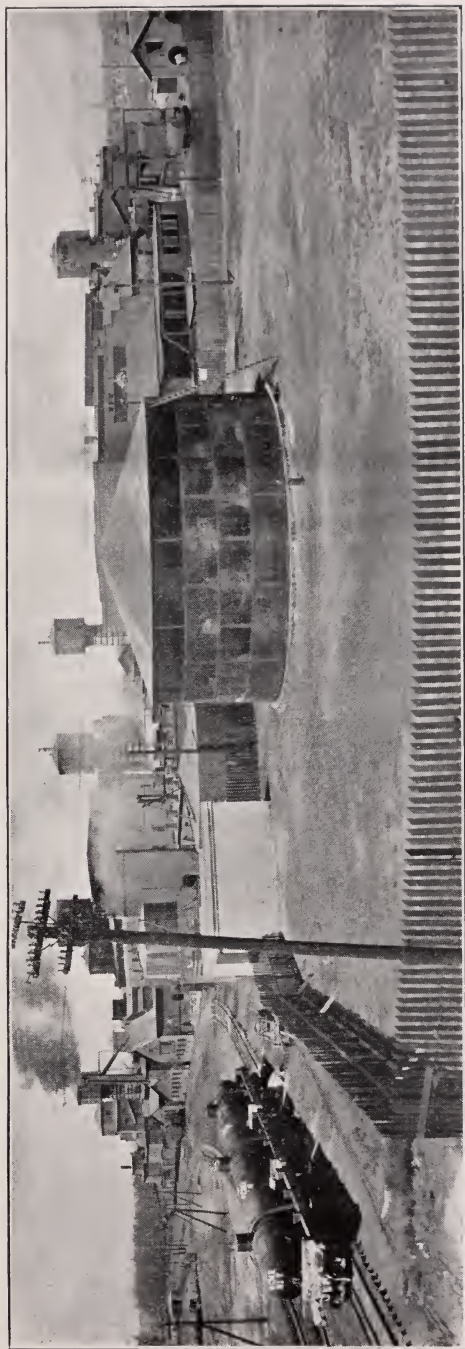
This is the only chemical plant in the Rocky Mountain region. There are several plants in California and one in Kansas City. One is now building in Montana.

The products of the Denver plant, not used in Colorado, are shipped to Kansas, Oklahoma, Texas, Montana, Utah, and Nevada.

The sulphide ores are treated by the magnetic separation and wet concentration process. The zinc, lead, and iron concentrates are sold to the smelters, and the sulphur is used in the manufacture of sulphuric and other acids.

While the ore is being roasted, the sulphur passes off to the acid plant, which consists of lead chambers, towers, and concentrating equipment. In passing off, the sulphur unites with oxygen to form sulphur dioxide—a gas—which is then oxidized with nitrate of soda, forming a sulphur trioxide. This product is mixed with live steam, which furnishes the hydrogen to complete the process of manufacturing sulphuric acid. This, however, leaves a weakened product, which must be concentrated. The old system of concentrating consists of heating the acid in platinum containers to drive off the excess moisture, but the plan adopted by the Western Chemical Company is that of passing the solution down through a tower, filled with suitable material. As the acid percolates to the bottom of the tower, it is subjected to a flow of hot producer gas, which drives off the moisture. Nitric and hydrochloric acid is made from the sulphuric acid.

The company also manufactures chemically pure sulphuric, nitric and hydrochloric acid for laboratory purposes, anhydrous and aqua ammonia, and liquid carbonic acid.



Western Chemical Mfg. Co. Plant, Denver, Colo.

The Denver plant supplies the trade with practically all the chemically pure acids used in its territory.

Sulphuric acid is used principally in oil- and silver-refining, chlorination, and copper-leaching. Nitric acid is used principally in engraving and in the manufacture of radium. The muriatic acid is used in sugar-refining, in the cyanide process, and for cleaning zinc shavings.

Anhydrous ammonia (a gas compressed into liquid) is used in the manufacture of ice. The aqua ammonia is used to some extent in refrigeration, for household purposes, and in metallurgical processes. The carbonic-acid gas is used in charging drinking-waters.

The company is enlarging its sulphuric-acid plant by installing roasters and towers. These improvements will cost \$50,000. The company expended \$150,000 in permanent improvements in 1913 and 1914.

Conservation and Leasing of Public Domain

There is, I apprehend, a serious misunderstanding in the United States, particularly in the East and South, regarding the western view of the conservation of our natural resources. It would be impossible in this brief article to explain this question fully. I wish merely to emphasize a few important facts.

I do not know of any westerner who is opposed to conservation, in the true sense of the term. We favor conservation, as opposed to waste. We do not believe our resources should be exploited for the benefit of the few. We do not believe our mineral and farm lands, water power, timber, and other resources should be monopolized by private owners. On the contrary, we welcome the assistance of the government in guarding our resources against waste and in teaching us how best to put them to beneficial use.

We object to bottling up natural resources for future generations, when we can find present use for them. We object to keeping away a population from these western states, while we are trying to encourage immigration. We object to harassing the settler or the developer with all manner of red tape annoyance and interference, which practically amounts to a breach of contract between him and the government. We believe the United States government should assist us in settling the western states, building up our population, encouraging industry, and increasing our taxable wealth.

Three-fourths of the area of Colorado pays no taxes to this state, because the land is owned by the government. This vast territory is not compact, but is spread over the whole state, with areas of population scattered here and there.

The importance of good roads in building up a new country cannot be overestimated. The good-roads movement has attracted the attention of all sections of the United States. Colorado has come to the front as one of the strongest advocates of this beneficial movement, because, if we wish to make our state populous, we must begin with transportation facilities. The citizens of Colorado, at the election in November, 1914, voted to tax themselves \$600,000 annually for good roads. This law is written into the constitution, and cannot be changed except by vote of the people at a general election. We are in earnest about building good roads. In addition to the sum of \$600,000 raised annually by direct constitutional tax levy, the sixty-three counties are contributing \$1,500,000 annually to the road fund, making a total of \$2,100,000 to be expended on highways every year.

The government owns three-fourths of the area of Colorado, yet its contributions to roads in this state amount to about \$70,000, and that sum is derived from the sale of timber *in the state to citizens of this state*. The Forestry Service sets aside 20 per cent of its revenue to be distributed for school and road purposes among the counties having forest areas. This fund amounts to approximately \$50,000 annually.

The people of the State of Colorado contribute their share to the fund, amounting to millions of dollars, expended annually in the improvement of rivers and harbors, although there are no harbors or navigable streams in this state or near it. On the other hand, revenue derived by the government from lands within this state is used largely in other states, while the government contributes not one cent collected from outside sources for the benefit of this state. The rain which falls within the state cannot be used by the state. The government demands that a large part of this water be not touched by a citizen of this state, but that it be surrendered to another state.

The national forests are infested with wolves, coyotes, bears, wildcats, mountain lions, and other beasts, which prey upon the live stock of the settler. The government spends not one cent in ridding the country of these pests. It is "conserving" them, if you please, for future generations. The state government pays bounties for the destruction of these beasts, which have their rendezvous in federal land areas.

The conservation laws read well. They appear to be fair, but they are interpreted by bureaucratic officials in Washington, who know little of the West and seldom visit it. One of the most surprising facts is that southern representatives in Congress, who would never forgive the carpet-bag government of post-bellum days, are among the staunchest supporters of a system of absentee landlordism practiced on the western states.

Conditions have greatly improved in recent years. However, administrations may change, but bureaucracy and its red-tape restrictions go on forever, under the guidance of the self-constituted friends of posterity. These "patriots" are now withholding as forest reserves, vast areas of land above timber-line, where no forest ever grew or ever will grow. The following table, giving the areas of these barren lands, was obtained from a government official:

ACREAGE ABOVE TIMBER-LINE IN THE VARIOUS FOREST RESERVES OF COLORADO

	Acres
Arapahoe.....	130,000
Battlement.....	1,300
Cochetopa.....	180,000
Colorado.....	120,000
Durango.....	56,000
Gunnison.....	60,000
Holy Cross.....	51,000
Leadville.....	385,000
Montezuma.....	50,000
Pike.....	107,500
Rio Grande...	186,500
Routt.....	27,500
San Isabel....	80,000
San Juan.....	80,000
Sopris.....	115,000
Uncompahgre..	100,000
White River.....	75,000

1,814,800

The total area of the forest reserves in Colorado comprised 14,648,000 acres at the time these figures were furnished.

LEASING

We believe the Washington bureaus desire to retain all the land of the West perpetually. Until a few years ago, the person settling on land was entitled to the land from the surface to the center of the earth. Then the bureaus decided that he was entitled only to the surface, and that, if he wanted the mineral contained in the land, he must make a separate filing on it. Now come the bureaucrats with a plan to forbid any citizen to acquire ownership to mineral lands. The plan is to continue the title with the government and to lease the land to the miner. Moving-picture plays and the "best sellers" usually depict the prospector as finding a new mine every day before breakfast. At this rate of progress, all the mineral veins soon will be taken up, and the prospectors will organize a trust. The facts are that not more than one prospector in a hundred finds a paying mine, and that usually the prospector must toil and tramp over the mountains for years, with no return for his time and labor if he does not strike mineral. But the Washington bureau experts, who never discovered a mine themselves, and who would not trade places with the prospector for a fortune, wish to withhold from him a

patent to the mineral vein his labor discovers. They would merely lease the claim to him on a royalty basis, and whenever he failed to live up to the terms of the lease he would lose his claim.

The lease might be fair and it might not. If previous contracts between the government and the settler are a criterion, I think it safe to predict that the lease would be unfair to the prospector. There are prospectors in Colorado who have held valuable mineral land for many years, awaiting someone with capital to assist in developing it. Under the leasing system the prospector would have been forced to give up his land because he had not developed it, although doing his utmost. With this condition facing the prospector, how many would go forth to search for mineral? Would the bureaus send out men to take his place? The history of mining shows that never has a mine been discovered by a so-called expert.

If it is the desire of the government to lock up the resources of the West, no better plan could be adopted than the leasing system. That this is the desire of the unpractical bureaucrats we have no doubt, but we despise the scheme to victimize the West on the plea of patriotism.

The discovery of mineral veins becomes more difficult each year, because the surface has been thoroughly prospected, and the future discovery of mines must depend largely on other methods than the pick. It is difficult enough at present to obtain capital for mining development; but how much more difficult will it be, if the investor is given to understand that a Washington "expert," who never managed a mine in his life, shall have the right to lay down rules for the development of the property!

People not familiar with mining may accept a leasing plan as satisfactory, but the miner knows it is not practical and will not work out in the Rocky Mountain states.

Colorado Mining Epitomized

During the week of the Knights Templar conclave in Denver 1912, but the percentages given on railroad tonnage, etc., vary United States, we issued a circular giving some facts regarding the mineral resources of Colorado. Ten thousand copies of the circular were printed, but there was a demand for more than twice that number. For several months afterward we received requests from mining men in various parts of the United States for copies of it. The circular, which follows, relates to the year 1912, but the percentages given on railroad tonnage, etc., vary only slightly from year to year.

Such literature could readily be issued from time to time by this department, if we had the funds.

COLORADO FACTS

"COLORADO is the LAND of OPPORTUNITY. There is more undeveloped wealth in Colorado than in any equal area in the world.

"Colorado was, is, and must ever be a MINING STATE. All other industries are dependent upon mining in this state.

"Colorado's agriculture depends upon mining for its BEST MARKET. The wise farmer will encourage mining development.

"The mines of Colorado supplied 85½ per cent of all the tonnage originating in this state on the D. & R. G., C. & S., Colo. Mid., and D. & S. L. Railroads in 1912, leaving only 14½ per cent to be supplied in 1912 by agriculture, manufacturing, and all other industries not associated with mining. And don't forget we had in 1912 the greatest agricultural crop in the history of the state. Is it not evident that the railroads of Colorado depend principally upon our mines? (See reports of railroads to State Railroad Commission.)

"There are 25,168 railroad employes in Colorado. At least 85½ per cent, or 21,518, depend upon mining for their jobs. These railroad men represent a pay-roll of \$21,000,000 annually, which comes from the profits of hauling MINING TONNAGE.

"The railroads of Colorado pay ONE-SEVENTH the taxes collected by the state, but since the mines maintain the railroads, this tax is paid indirectly by the mining industry. Besides this, the mining counties pay directly ONE-HALF of all the taxes collected by the state from the counties outside Denver. It is evident, therefore, that the mining industry pays more than one-half of the taxes collected by the State of Colorado outside of Denver.

"The mining industry receives only ONE DOLLAR from the State Legislature and the federal government for every FIVE DOLLARS spent in behalf of and to encourage the agricultural industry.

"*Eighty thousand* people in *Denver* depend upon mining for their livelihood. *Twelve thousand* people are employed in Denver in the following: American Smelting and Refining Company; offices and smelter; coal companies' offices, yards, and stables; mine and machinery supply houses; chemical works, assay offices, mining engineers, metallurgists; brick, tile, and stone plants and railroads. These represent a population of at least 60,000. Put 60,000 employed people on a desert, and they will create a demand for 4,000 merchants, doctors, lawyers, dentists, real-estate brokers, mechanics, laborers, etc., and their families, or 20,000 people. In short, there will be a city of 80,000 people.

"Every railroad SCENIC ROUTE in Colorado was built to reach the MINES. These routes are maintained by the TONNAGE of the mining camps. What would become of Colorado's TOURIST business but for the mines?

"There are scores of the most beautiful places in Colorado which are not seen by the tourist because not reached by the railroads. The railroads will not go there until MINES have been discovered. If we wish to ENLARGE the tourist business and make Colorado the SWITZERLAND OF AMERICA, the PLAYGROUND OF AMERICA, we should encourage mining development.

"Colorado employs 50,000 miners, who, with their families, represent a population of 200,000. The miners give employment to 21,500 railroad men ($85\frac{1}{2}$ per cent of the whole), who, with their families, represent a population of 107,500. That makes a total of 307,500 directly dependent upon mining. Add the merchants, professional men, mechanics, and others dependent upon mining, there being at least 15,000, and their families representing 75,000 people, or a grand total of 382,500 people in Colorado depending upon the mining industry *today*. This is nearly one-half the population of Colorado.

"Every millionaire who died in Colorado in the last ten years made his fortune in mining, except two. One of these was largely interested in mining enterprises, and his bank was organized with mining capital.

"Two-thirds of Colorado's rich men know more of the miner's pick than of the plow or the cash register.

"How did Colorado's rich lawyers make their money? The miner's fees are fortunes.

"Only 35 per cent of Colorado's mineral resources have been touched, and that only in part. Colorado contains more gold than has ever been produced, more silver than has ever been mined. It produces nearly the entire tungsten supply of the world. It is the

only radium center in the Western Hemisphere and practically the only source of this metal in the world.

"Colorado produced, last year, \$13,000,000 in lead, copper, and zinc; yet we have no white lead, zinc lead, copper wire, copper utensil or any other kind of factory to handle these products.

"We are losing an annual pay-roll of \$50,000,000 by failing to manufacture these metals. We HAVE THE MARKET. If we have a market for all raw material we produce, why cannot we have a market for the manufactured material? There is more revenue for the railroads in handling manufactured products than in hauling the crude material. When Colorado decides to encourage manufacturing, we will get reduced freight rates.

"Think of our loss in failing to manufacture tungsten steel in this state! Why is Colorado not the center of automobile steel, tool steel, incandescent lamp, and other manufacturing industries?

"We have the coal, power, and raw products. Put a hammer in a man's right hand and a nail in the other. If he tells you he cannot drive the nail, have his head examined. So it is with manufacturing in Colorado. Encourage manufacturing, and Colorado will have a pay-roll of \$100,000,000 in that industry alone.

"Encourage mining, and Colorado will treble its production in ten years, quadruple its pay-roll, and make the state *rich, populous, prosperous, and happy*. Then will come the real days of the Switzerland of America, the days of plenty and big prices for the farmer.

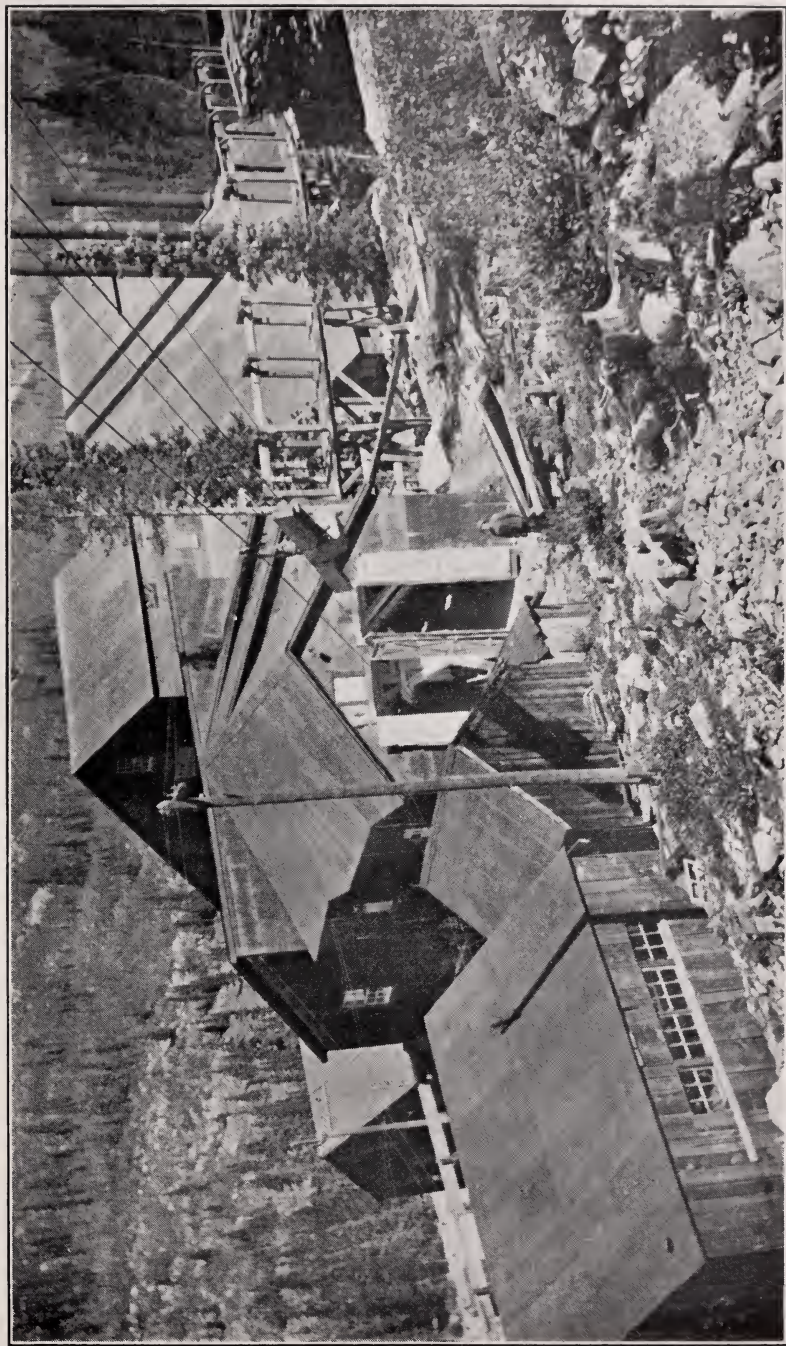
"Statistics prove mining is a safer business than 90 per cent of all other enterprises. The only man who fails is he who buys a pig in a poke, who takes a blind chance, who is a fool with his money.

"Before you buy a bond you consult your banker; before you buy land you go see it, or send an agent. When you buy mining property, do likewise. If you do not know a mine when you see it, engage a competent mining man to make examination and report, or get the opinion of one upon whose judgment you know you can rely. Then your investment will be as safe as any other.

"Mining principally is manufacturing. The big problem is to handle at a profit. Hundreds of mines are opened in Colorado which need capital for economical development. Mining is a business like any other. It takes brains and business methods to succeed in mining. Men make failures as farmers on good farms, lacking business methods. So it is with mining. Look before you leap, invest intelligently, use business methods, and you will have greater success in mining than in any other enterprise.

"For further information, address the Colorado State Bureau of Mines, Capitol Building, Denver.

T. R. HENAHEN,
Commissioner of Mines."



Golf Tunnel Buildings on Left. Lower Terminal of No. 14 Tramway in Center. Trestle for Smelting Ore on Right. Part of Big (Concentrating) Mill Behind. Lumber Being Sent Up on Tramway.

The Colorado Metal Mining Association

In the days of Colorado's youth, when mining was practically the only industry, there was no need of an organization to foster that industry; but, as years rolled by, other industries sprang into prominence. These industries organized associations for mutual benefit, while the miner continued to work out his destiny individually. The result was that the law-making bodies, press, and public had been given a false notion of the greatest industry of the state.

Early in 1913 I decided to effect an organization of the mining men of the state, but the plans did not mature until the close of that year. A call for a state convention was issued, under the terms of which the persons interested in mining in each county were invited to hold a county convention and select delegates to the state convention. The convention was held in the State Capitol February 19-20, 1914. Twenty-nine counties responded, with a total of 187 delegates. The convention organized the Colorado Metal Mining Association, with branches in each county represented. A director was named for each county, and this board has control of the affairs of the association. The officers elected for the first year and the resolutions adopted by the convention follow:

OFFICERS

President, Bulkeley Wells	Telluride
First Vice-President, George O. Argall	Leadville
Second Vice-President, Nelson Franklin	Victor
Third Vice-President, Henry C. Bolsinger	Bald Mountain
Secretary, John M. O'Connell	State Capitol, Denver
Treasurer, A. M. Collins	Creede

Executive Committee

Bulkeley Wells	Telluride
John M. O'Connell	State Capitol, Denver
R. M. Henderson	Breckenridge
Thomas R. Henahan	State Capitol, Denver
James Doyle	La Plata
C. H. Hanington	204 Boston Building, Denver
E. M. Moscript	Idaho Springs
John G. Clark	Boulder
Jesse F. McDonald	Leadville

Directors

Name	County	Post-Office
Fred D. Stanley	Alamosa	Alamosa
Eugene Stevens	Boulder	Boulder
M. R. Jewell	Chaffee	Salida
E. M. Moscript	Clear Creek	Idaho Springs
James E. Ray	Custer	Westcliffe
Joseph Meredith	Dolores	Rico
Thomas R. Henahen	Denver	State Capitol, Denver
C. H. Hanington	Eagle	204 Boston Building, Denver
George M. Taylor	El Paso	Colorado Springs
W. H. Trout	Fremont	Canon City
M. E. Swigart	Garfield	Carbondale
Henry C. Bolsinger	Gilpin	Bald Mountain
John F. Pearson	Gunnison	Ohio City
B. N. Ramsey	Hinsdale	Lake City
George O. Argall	Lake	Leadville
James Doyle	La Plata	La Plata
A. M. Collins	Mineral	Creede
J. J. Shideler	Montezuma	Mancos
John I. Mullen	Montrose	Naturita
B. H. DuPraw	Ouray	Ouray
W. A. Spooner	Park	Alma
Guy V. Newton	Pitkin	Aspen
Ben T. Wells	Pueblo	211 W. 12th St., Pueblo
Ezra T. Elliott	Rio Grande	Del Norte
Norman Roberts	Saguache	Crestone
Joe T. Terry	San Juan	221 Coronado Bldg., Denver
Bulkeley Wells	San Miguel	Telluride
R. M. Henderson	Summit	Breckenridge
Nelson Franklin	Teller	Victor

COMMITTEES

Finance

L. G. Carlton	Cripple Creek
Charles E. Anderson	Aspen
B. B. Allen	Silverton
Frank Brady	Empire
L. E. Girard	Boulder
B. P. Morse	Denver
J. Clarence Hersey	Leadville

Publicity

V. I. Noxon	Boulder
E. J. Carter	Telluride
Warren Prosser	Silverton
Captain James T. Smith	News, Denver
W. J. Stull	Central City
A. E. Francis	Cripple Creek
Henry C. Butler	Leadville

Legislation

George M. Taylor	Colorado Springs
J. W. Deane	Aspen
John R. Wolff	Boulder
John T. Joyce	Silverton
George B. Clark	Pueblo
Carroll M. Carter	Ohio City
John A. Ewing	1030 First National Bank Building, Denver

Mining and Milling

A. E. Moynahan	Alma
William Loach	Boulder
R. W. Blackett	Silver Cliff
John I. Mullen	Naturita
Fred G. Farish	315 Colorado Building, Denver
John R. Champion	Leadville
Thomas B. Crowe	Victor

RESOLUTIONS

Following is the complete text of the resolutions, as adopted on final reading at the first annual meeting of the Colorado Metal Mining Association, held at Denver, Colorado, February 19-20, 1914:

Resolution No. 1

"WHEREAS, Organization is the primary purpose of this meeting, and the deliberations of a convention such as this lead to no material results unless constantly supported and promoted by a working organization embracing all the influence and power of great numbers and vast interests identified with the mining industry; be it therefore

"*Resolved*, That this body at once proceed to the organization of a State Metal Mining Association, and that a committee consisting of one member from each county herein represented, to be chosen by the delegation thereof, be selected to formulate a plan of organization, and a constitution and by-laws, to be reported to this convention for consideration at the earliest possible moment."

Resolution No. 2

"WHEREAS, The taxation of the metalliferous mines at the present time places upon the mining industry an unfair burden; and

"WHEREAS, The mining industry is one of the chief sources of revenue and valuation; be it therefore

"Resolved, That such steps be taken by this organization, in conjunction with the Tax Commission and other authorities, by such ways and means as may be deemed proper and expedient, more fairly to equalize the burden; and be it further

"Resolved, That the taxation of mines should be based upon the values received from the ores, rather than on the gross assay value, as the difference between these figures in the zinc and in the low-grade gold-silver districts ranges from 17 to 35 per cent, said percentages being a total loss as far as the miner is concerned."

Resolution No. 3

"WHEREAS, A bill is being considered by the Committee on Mines and Mining of the United States Senate (S. R. 4405) which purports to provide for and encourage prospecting and mining of radium-bearing ores in lands belonging to the United States, for the purpose of securing an adequate supply of radium for government and other hospitals in the United States, and for other purposes; and which bill also provides that claims containing said radium-bearing ores, located after the passage of this act, shall be mined not less than four months each year, and that the ore therefrom shall be sold to the government at the market price, fixed by the Secretary of the Interior; and which bill also gives the government the power to enter upon lands that have been patented, and to mine, develop, and remove said radium-bearing ores in the event that the patentee, his lessees or assigns, shall fail to develop and mine such ores with reasonable diligence; be it therefore

"Resolved, That we congratulate the congress upon abandoning the original bill presented (H. J. R. 185), which provided for withdrawal of radium-bearing ore lands, as indicative of sympathy with the unanimous belief of this convention that all of the lands within the boundaries of the State of Colorado belong of right to the people of Colorado, and should be developed as our people see fit; and be it further

"Resolved, That we are unalterably opposed to the proposal that radium-ore claims located after the passage of S. R. 4405 shall be worked at least four months each year, the present law being onerous enough; and be it further

"Resolved, That we regard as unwise and unjust the idea that the miner of radium-bearing ores, as above provided, shall sell the same exclusively to the United States; the right of contract should not be annulled nor abridged, but the federal Bureau

of Mines is hereby requested to establish a sampling plant or plants for the determination of values in radium-bearing ores; that a fiscal agent be attached to said plant or plants, so that the prospector and miner may be given a competitive cash market for his ore, based upon an equitable valuation of the radio-active mineral therein contained."

Resolution No. 4

"Resolved, That the state commission in charge of the Colorado exhibit at the Panama-Pacific Exposition in San Francisco give the metalliferous mining industry of the state the broadest representation possible, to the end that all districts in the commonwealth, both prominent and yet only partially developed, may be given the benefit of intelligent publicity.

"WHEREAS, The reputation of Colorado as the chief producer of radio-active ores is at present world-wide; be it therefore

"Resolved, That the radio-active ores be made a prominent feature in the proposed Colorado exhibit, and that this idea be commended to the favorable consideration of the commission in charge."

Resolution No. 5

"WHEREAS, The development of the mines in many of the Colorado districts is very largely dependent upon home pools and sets of leasers made up of practical miners; be it therefore

"Resolved, That this convention commends the home pool plan of development and operation, and calls upon resident and non-resident mine-owners to deal liberally and equitably with home pools and with leasers, to the end that many mines now idle may be worked to the advantage of the district in which they are located, and to the gain of the state at large."

Resolution No. 6

"WHEREAS, In many instances the mine operator and Forest Service conflict upon the public domain in the building of power lines, roads, telephones, and the various accessories of mining enterprises, in which conflicts great delay is often experienced by the operator in getting right-of-way as well as immediate recognition from the service, often entailing loss both of time and of money; be it therefore

"Resolved, That this association appoint and delegate a committee, to act in conjunction with the proper authorities of the Forest Service, in an effort to have set aside those conditions which tend to delay; and be it further

"Resolved, That this convention favors and solicits government aid in building roads into fields of mineral possibilities, where the apparent value of the district justifies such expenditure, especially where the government expects to realize from its timber resources."

Resolution No. 7

“Resolved, By this convention, in meeting assembled, that it is the sense of this meeting that we do at this time ask that in the future the press of the state direct a larger portion of their energy and space to the building-up and protection of the mining industry of the state.”

Resolution No. 8

“Resolved, That the mining men of Colorado recognize and appreciate the great value of the work undertaken by the United States Bureau of Mines in establishing an experimental station at Denver, to aid in solving the many questions connected with the utilization of the low-grade and complex ores of the West, and we pledge the hearty co-operation of this organization.”

Resolution No. 9

“WHEREAS, In some districts of the state, where there is no railroad competition, discrimination in freight rates is a matter of considerable importance to those engaged in the metal-mining industry; be it therefore

“Resolved, That the State Railroad Commission be earnestly requested to give immediate attention to this subject, to the end that relief may be afforded to the districts affected.”

Resolution No. 10

“Resolved, That the Executive Committee or Board of Directors of this association be directed to request a sufficient appropriation from the legislature for the proper classification and the enlargement of the mineral museum at the Colorado State Capitol. This collection has won first prize at every world's fair at which it has been exhibited, and is of distinct educational value. Its usefulness can be greatly increased by having it properly arranged and classified. Be it further

“Resolved, That the Executive Committee be directed to frame a bill for an appropriation by the Twentieth General Assembly for sufficient funds to classify, print, and publish the laws relating to the metal-mining industry of this state, to be distributed free to prospectors, miners, and those interested in the metal-mining industry. Be it further

“Resolved, That the Executive Committee be directed to urge upon the Twentieth General Assembly the necessity of increasing the incidental expense fund of the State Bureau of Mines sufficiently to enable that department to purchase needed books, maps, and other documents, and to publish bulletins relating to the metal-mining industry. Be it further

“Resolved, That the legislature be requested to increase the number of metal-mining districts from four to six, and that a

state mine inspector be located in each, in order to give proper protection to the safety of working miners. The Executive Committee is hereby directed to draft such a bill for presentation to the legislature. Be it further

"Resolved, That the Executive Committee be directed to draft a bill, to be presented to the next legislature for passage, relating to the prevention of fake mining schemes and mine methods."

Resolution No. 11

"WHEREAS, The State Geological Survey, by its field investigations, its publications, maps, and various other lines of work, is rendering a most valuable service to the mining industry of the state, and the field of its possible usefulness is practically unlimited; and

"WHEREAS, Its services and work have been hindered, and at times crippled, by the delay in paying the appropriations made for its support by the legislature; be it therefore

"Resolved, That this association pledges itself to use its best endeavors to secure such legislation as will insure the prompt payment of appropriations and enable the survey to carry on its work in an efficient and satisfactory manner."

Resolution No. 12

"Resolved, That the thanks of this convention are hereby extended to State Mine Commissioner Henahen and his efficient office force, for their effective work in assembling this body, which is the widest representation with which mining has been favored in many years; and be it further

"Resolved, That this association tenders its aid and co-operation to the State Mining Bureau, the State Geological Department, and the State School of Mines, in their efforts for the advancement of the mining industry; and that the thanks of this convention are extended to the Board of Capitol Managers for the use of the Capitol Building for this convention."

The next annual meeting of the association will be held in Denver in January, when the delegates will discuss questions of legislation pertaining to the metal and rare-mineral mining industry. This association is now thoroughly organized and already has accomplished great results. The mining men of the state are glad of the opportunity to meet together and exchange views, and to make suggestions for their mutual benefit.

The county associations in various counties have been active in local matters and have aroused the enthusiasm of the mining fraternity.

Membership in the association is open to prospectors, miners, operators, and all persons directly interested in the metal or rare-mineral industry of this state.

Legislation

DUTY OF STATE IS TO ENCOURAGE MINING INDUSTRY

I desire to direct the attention of the Twentieth General Assembly to the need of legislation for the benefit of the mining industry. Although the General Assembly usually is in session ninety to one hundred and twenty days, little time has been given in the past to the needs of the metal-mining industry, which made Colorado a great state and which, with proper encouragement, will make it the richest in the Union.

The mining industry receives from the state only \$1 to every \$5 contributed to agriculture. The assistance given the agricultural industry has been a paying investment, and similar aid given the mining industry would react in a like manner.

In the last session of the legislature only three measures concerning the metal-mining industry were considered. Two of these bills related to the width of lode claims, and they were contradictory. One bill provided that the width of lode claims in all counties shall be not in excess of 300 feet; while the second bill, passed thirty days later, provided that the width of lode claims shall be 600 feet in all counties, save four named in the bill. The Colorado Metal Mining Association probably will indorse a bill, to be introduced in the present session, setting this question aright.

MINE TAXATION

The only other bill relating to the metal-mining industry, considered at the last session of the legislature, was one pertaining to mine taxation. There are some theorists who believe that a mine should be assessed on the selling price of the property. This is fundamentally wrong. The speculative price of a thing is not its real value. Mining is a speculative business. Vast sums have been paid for mines that proved worthless. The buyers were speculators; for no man can see through the ground. Ore must be wrested from the earth and converted into commercial mineral before it has a value.

The progress of Australia, like that of Colorado, centers about the precious metals. Australia began its development as an agricultural and grazing country. Land values increased. A boom was on. It failed. The country was threatened with depopulation, when gold was discovered. Immediately the deserting population returned, accompanied by thousands of new immigrants. Then they wanted to tax the miner's right to look for mineral. The miners rebelled, and the people came to their senses.

Alaska was a barren waste until mining was commenced. Since then Alaska has built up an agricultural industry.

One mine in Australia was worked for twenty-one years before any ore was produced, and then it paid back all that was invested, and fortunes besides. Another mine was developed for seventeen years before the miners received the rich reward to which they were entitled. There are many mines in Colorado that have been under development for years, sometimes getting out a little ore and sometimes none. Is it fair to tax the capital invested in such enterprises, when every mine discovered in this state adds to the welfare of Colorado? Does anyone suppose the Australian miner, who worked and spent his money for twenty-one years on a mine, would have done so if he did not believe he would have encountered ore in a few months? His judgment naturally should be considered weightier than that of an assessor, who may know nothing of a mine. The miner probably would have asked a stiff price for his property at any time during its stages of development, because he had confidence in it; yet, even after twenty-one years, he might have failed to reach mineral. Certainly it would have been unfair to tax the confidence of the miner, based on the speculative price he asked for his property. It was time enough to tax him when he began to take out ore in paying quantities.

NET PROCEEDS PROPER BASIS

Assessments on mining properties should be based on the output—the net output. It should be borne in mind that a mine may produce a large quantity of ore at a loss; yet the Nineteenth General Assembly passed a law, basing the value of a property on one-half the gross proceeds, plus all the net. The miners of Colorado are opposed to this law, on the grounds that it is unfair, discriminatory, and extortionate. If all mines were alike in cost of production, class of ore produced, cost of treatment, and cost of transportation, the plan could be made equitable; but since some mines show a wide variance between the gross and net proceeds, while others show but a small difference, the system is unfair. For instance, one mine may produce \$100,000 in gross proceeds, out of which it will net \$75,000, while another may produce \$100,000 gross and operate at a loss. If it is fair to assess the first mine at \$125,000, based on its output, it is manifestly unfair to assess the second mine at \$50,000, based on its output, since its output was obtained at a loss. But if the mines are assessed on the basis of their net output, the earning mine will be taxed, and the one operated at a loss will not be taxed, except as mineral land. This is proper encouragement. The miners do not wish to escape taxation, but they desire a law that guarantees them a square deal.

The investor who puts his money in a mine that has not reached a paying stage is giving employment to workmen and buy-

ing supplies of our merchants and manufacturers. Other states encourage manufacturing and other industries for this very reason. In many places factories are exempt from taxation for a term of years, land sites are donated, and the citizens contribute to the capital. The Colorado miner finds no such encouragement. Usually he must seek elsewhere for his capital. The state offers him no inducements whatever.

MINERS WIN IN COURT

When the law passed by the Nineteenth General Assembly became operative, some of the assessors attempted to place upon it a construction that was extortionate. They contended that the gross proceeds of a mine consisted of the assay value of the ore produced. For instance, if a mine produced a gold-silver-lead-zinc ore valued at \$25 a ton, the assessor interpreted the law to mean that the ore should be assessed at \$25. No account was taken of the following conditions: First, the miner may not be able to save more than 50 to 60 per cent of the values in the ore, the balance being unrecoverable. (This is the rule, with few exceptions.) Second, the presence of zinc in the ore makes it all the more difficult to treat, and therefore the miner is required to pay higher treatment charges, or, as commonly expressed, he is penalized for the zinc. Third, one or more of the metals may not be present in commercial quantities, and hence he receives no pay for them. Fourth, the cost of transportation varies according to distance from smelters.

The miner contended that the gross proceeds of an ore meant the value he got out of it; namely, the price paid him by the smelter after smelter and transportation charges were deducted. For example, the assay value of the ore at the mine may be \$25, but the ore have a market value of only \$8 at the smelter. The Supreme Court sustained the contention of the miners.

ENCOURAGEMENT NEEDED

The two greatest industries of Colorado are mining and agriculture. Because the mining industry has not been advertised in Colorado, we sometimes hear that its glory is past and that the future of the state depends upon its agricultural and scenic resources.

It is true that Colorado is destined to be one of the greatest agricultural states in the Union, but its chief dependence is on its mines.

Farming in the Mississippi Valley before the Civil War afforded a living to the farmers, but scarcely more. As the population of the Mississippi River valley increased, the farmer found a market for his products, and his condition improved. Farming would have been quite unprofitable in Colorado before gold was discovered here and brought a population of miners. It would

not be a profitable enterprise if our mines should cease operations and the miners leave the state. If the western fruit-growers had a larger home market in the mining camps, they would not worry about the eastern market. It is obviously the duty of Colorado to encourage a population that will be a market for the farmer, as much as to encourage the farmer.

A large part of Colorado can never be put under cultivation, either because of the altitude, the ruggedness of the surface, or the aridity. Yet most of the non-agricultural land is mineral-bearing, either metal or non-metal. These resources should be developed, thereby increasing our population and assuring prosperity to all.

One never hears of an association of real-estate men giving much attention to the advertising of our mineral resources—it is not in their line. Selling mines is the duty of the individual, and usually the individual does not want to sell, but to obtain financial aid in developing his property—hence no “boosting” by brokers. On the other hand, agricultural lands and city property are handled almost altogether by brokers, who see that these are not wanting in publicity. The printed word works marvels. And yet there would be no railroads in most parts of Colorado, and no scenery within reach, if the mines of this state would cease operations. If we increase the extent of mining operations, we shall encourage railroad-building, agriculture, manufacturing, and tourist traffic. Mining is the ladder by which this state has climbed and is still climbing. Now we find some of our newest “boosters” apparently willing to take away the ladder.

LINCOLN'S MESSAGE

This is the message Abraham Lincoln gave to Schuyler Colfax, when he was about to make a trip to the West:

“I want you to make a speech for me to the miners you may find on your journey. I have very large ideas of the mineral wealth of our nation. I believe it practically inexhaustible. It abounds all over the western country, from the Rocky Mountains to the Pacific, and its development has scarcely commenced.

Now the rebellion is over and we know pretty nearly the amount of our national debt, the more gold and silver we mine makes the payment of that debt much easier. I am going to encourage that in every way.

We shall have hundreds of thousands of disbanded soldiers, and many have feared that their return home in such great numbers might paralyze industry by suddenly furnishing a greater supply of laborers than there will be demand for.

I am going to try to attract them to the hidden wealth of our mountain ranges, where there is room for all. Immigration, which even the war has not stopped, will land upon our shores hundreds of thousands more every year from overcrowded Europe.

I intend to point them to the gold and silver that wait for them in the West.

Tell the miners for me that I shall promote their interest to the utmost of my ability, because their prosperity is the prosperity of the nation. We shall prove in a very few years that we are indeed the Treasury of the World."

STATE'S MINERAL WEALTH

When we think of mining in Colorado, we have in mind only the precious minerals. We do not consider our resources in coal (enough to supply the world for one hundred years); our mineral springs and waters (more numerous than, and equally as beneficial as, those of Europe which annually pour millions of dollars of American money into the purses of their owners); our granites, (superior to any quarried in the United States and unlimited in supply); our sandstone (the finest grade quarried in the United States); our marble (the winner over all marbles in the United States in a competition for use in the Lincoln national memorial); our clays (abundance of every species); our gypsum, fluorspar, iron, oil, precious stones, and many other minerals—all in the infancy of development and awaiting a proper public spirit in this state, which will herald these riches to the world and invite capital. New Jersey, one of the smallest states in the Union, produces \$20,000,000 annually in clay products; yet there are counties in Colorado that contain more clay resources than New Jersey.

Since we have given so little encouragement to metal-mining, it is scarcely to be wondered at that other rich mineral resources are seldom thought of.

MINING LAWS

This department is in receipt of hundreds of requests annually for copies of our mining laws. I recommend to the General Assembly that appropriation be made for the codification and publication of our mining laws for free distribution by this department. The laws are of interest to prospectors, working miners, operators, and investors. The expense of publishing a pamphlet containing these laws would not be great. Nearly all the mining states of the nation have published such laws.

PANAMA-PACIFIC EXPOSITION

The legislature should make ample provisions for a proper display of the mineral resources of Colorado at the Panama-Pacific Exposition to be held in San Francisco in 1915. The time is short, and we should begin preparations immediately. It is to be hoped that this question will receive the attention of the General Assembly at an early date.

The Nineteenth General Assembly failed to make provision for the Colorado exhibit. Governor Ammons has been trying through the assistance of committees, to have all the preliminary work completed, so that the work can be taken up immediately, and the exhibits forwarded and installed without delay, after an appropriation has been made therefor.

It is our duty as a state to exhibit our resources at an international exposition, and more especially when it is to be held in a neighboring western state.

The Colorado mineral exhibit has won first prizes at all famous expositions, beginning with that of Chicago.

Following is the committee appointed by Governor Ammons to have charge of the Colorado mineral exhibit at San Francisco: Bulkeley Wells, Telluride; T. R. Henahan, Commissioner of Mines, Denver; A. B. Frenzel, Denver; Samuel D. Nicholson, Denver; Dr. W. S. Ward, Denver; Professor R. D. George, State Geologist, Boulder; William G. Haldane, president Colorado School of Mines, Golden.

EXPERIMENT AND SAFETY STATIONS

I desire to call the attention of the legislature to a bill introduced in Congress, which provides for the establishment of mine experiment and mine rescue stations in the western mining states and Alaska.

The low-grade-ore problem is the most serious affecting the western miner. After a mine has been discovered, developed, and the ore removed, there still remains the problem of extracting the values from it. This is the problem of the metallurgist. The United States government has taught the farmer how to make his farm more profitable by producing larger crops, improving his soils and animals, fighting pests, and building great irrigation projects. No similar assistance has been given the miner. The western miner has asked the assistance of the government in extracting the values from his ores. He is now recovering only 40 to 80 per cent of the values in most ores. With every increase in the percentage of extraction (if the cost of extraction does not increase correspondingly), the value of the mine is greatly enhanced. For example, if a mine is paying dividends on an extraction of 50 per cent of the value of the ores, it is apparent that, if the extraction be increased to 80 or 90 per cent, without a corresponding increase in the cost, the difference of 30 or 40 per cent is clear profit. Mines now idle could then be worked at a profit.

The object of the above bill is to obtain the assistance of the United States government in teaching the miner how to extract a greater value from his ore, and how to promote health and safety in mines. The problem is too great for the individual miner, just as the problems of the farm are too serious for the individual

farmer. The government and the nation have profited by the instruction given to the farmer through the agricultural industry. Farming has been revolutionized. We expect similar results in the mining field, if the government will devote its attention to the low-grade and complex-ore problems.

The values that are not recovered are wasted. There is only one supply of metals in the world, and it behooves our government to devote its attention to this practical conservation problem.

I urge the Twentieth General Assembly to adopt resolutions favoring this bill, and recommending that at least one of these mine experiment stations and one mine safety station be located in Colorado.

Since the bill invites the several mining states to co-operate with the United States government, just as the agricultural colleges now co-operate with the United States Agricultural Department, I recommend that the General Assembly appropriate \$10,000 as Colorado's share of the cost of operating a mine experiment station in this state for the biennial period, on condition that this bill be passed by Congress.

MINERAL MUSEUM

I recommend to the General Assembly that provisions be made for the proper classification and arrangement of the Mineral Museum. This collection is visited by scientists and mining men from all parts of the world, and it should be properly arranged and classified.

BUREAU OF MINES

The efficiency of the Bureau of Mines is restricted though lack of sufficient employes. The districts assigned to the four inspectors are too large for thorough work. In order to give proper attention to the metal and non-metal branches of the mining industry, not including coal, the department should have six metal-mine inspectors and one inspector for assignment to other duties. The present staff consists of four inspectors only.

INCIDENTAL EXPENSE FUND

The incidental expense account allowed this department is not sufficient. It is barely enough to provide for postage and stationery. The department is in need of books, maps, and other material for its reference library, and there should be sufficient funds for the publication of bulletins, as occasion requires.

Geology of Colorado

Many requests are received by this department for information regarding geological publications on Colorado. We have a complete set of the publications of the United States Geological Survey and the Colorado State Geologist in the reference library of this department, at the service of the public. These publications include geological bulletins, water-supply papers, professional papers, monographs, annual reports, mineral resources, geologic atlas folios, topographic folios, etc.

The monographs and atlases published by the United States Geological Survey can be purchased at cost on application to the office of that department in Washington, D. C. All other publications of the government and all publications of the State Geologist are distributed free. This department receives only one copy of each for the reference library.

Following is a directory of the publications of the United States Geological Survey, relating to Colorado:

Abbreviations: A, annual reports; M, monograph; P, professional papers; B, bulletin; W, water-supply paper; M. R., mineral resources; T. F., topographic folio; G. F., geologic folio; S. P., special publication.

Alunite, San Cristobal district.....	B 530 f	Mesa County.....	B 471 h
Asphalt.....	A 22 i b	Moffat County.....	B 541 k
Carnotite.....	B 262, 315 c, 340 d	Northwestern part... B 316 e, 341 c, 415	
Cement materials.....	B 243, 380 j, 522	South Park field.....	B 381 c
Clay, Denver Basin.....	M xxvii	Spanish Peaks district.....	GF 71
El Paso County.....	B 470 g	Trinidad field.....	B 381 c
Southwestern part.....	B 315 i	Walsenburg district.....	GF 68
Coal.....	A 22 iii j; B 471 j, 531 m, 541 k	West Elk Mountains.....	B 510
Anthracite-Crested Butte dis-		Yampa field.....	B 285 f, 297
trict.....	GF 9	Copper.....	B 340 b
Book Cliffs field.....	B 316 e, 371	Colorado Plateau.....	B 260
Canon City field.....	B 381 c	Hinsdale County.....	B 470 b, 478
Colorado Springs field.....	B 381 c	Montrose County.....	B 285 b
Delta County.....	B 471 h	Pearl region.....	B 213
Denver Basin.....	M xxvii; B 381 c	Silverton district.....	GF 120
Durango-Gallup field, B 285 f, 316 e, 341 c		Unaweep district.....	B 580 b
Elmore district.....	GF 58	Ferberite.....	B 583
Grand Mesa.....	B 341 c, 510	Forests, Battlement Mesa reserve..	A 20 v c
Gunnison Valley.....	B 471 h	Pikes Peak, Plum Creek, and	
La Plata County.....	B 541 k	South Platte reserves.....	A 20 v b

- White River Plateau reserve... A 20 v c
 Fossils..... A 8 i d,
 20 ii c; M xl P 16; B 93, 391
 Gazetteer..... B 291
 Geology, Anthracite district..... GF 9
 Apishapa district..... P 90-c; GF 186
 Arkansas Valley..... A 17 ii f; P 52
 Boulder district..... B 265
 Buffalo Peaks..... B 1
 Crested Butte district..... GF 9
 De Beque oil field..... B 531 c
 Denver Basin..... M xxvii
 Elmoro district..... GF 58
 Engineer Mountain..... GF 171
 Grand Mesa..... B 510
 Leadville district..... B 386
 Needle Mountains..... GF 131
 Nepesta..... GF 135
 Northwestern part..... A 9 e
 Pueblo district..... GF 36
 Rangely district..... B 350
 Rico Mountains..... A 21 ii a
 San Luis Valley..... W 240
 Spanish Peaks district..... GF 71
 Tenmile district..... GF 48
 Walsenburg district..... GF 68
 West Elk Mountains..... B 510
 Geology, gold, etc., Aspen district.. M xxxi
 Bear Creek..... B 285 a
 Geology, gold, etc., Breckenridge
 district..... P 75
 Geology, gold, etc., Creede..... B 530 e
 Cripple Creek district..... A 16 ii n;
 P 54; B 254, 260
 Custer County..... A 17 ii c
 Durango district..... B 260
 Empire district..... P 63
 Georgetown district..... P 63; B 260
 Gunnison County..... B 380 a
 Hahn Peak..... B 285 a
 Hinsdale County..... B 470 b, 478
 Idaho Springs district..... P 63; B 285 a
 Lake City region..... B 260, 478
 La Plata district..... GF 60
 Leadville..... A 2 d; M xii; B 320
 Montrose County..... B 285 b
 Ouray district..... B 260; GF 153
 Pikes Peak district..... GF 7
 Rico district..... A 22 ii c; GF 130
 Rosita Hills and Silver Cliffs.. A 17 ii b c
 Routt County..... B 340 a
 Silverton district.. B 182, 315 a; GF 120
 Telluride district..... A 18 iii f; GF 57
 Gold. See Colorado, geology, gold, etc.
 Granite..... B 540 k
 Gypsum..... B 223
 Eagle County..... B 470 g
 Pueblo district..... GF 36
 Uncompahgre region..... B 285 k
 Iron, Taylor Peak and Whitepine
 districts..... B 380 e
 Irrigation near Greeley..... W 9
 Laccoliths..... A 14 ii d
 Landslides, San Juan Mountains... P 67
 Lead, Breckenridge district..... P 75
 Custer County..... B 580 c
 Creede..... B 530 e
 Hinsdale County..... B 478
 Leadville district..... A 2 d; M xii; B 320
 Silverton district..... GF 120
 Leveling..... B 486, 565
 Mien..... B 530 l, 580 f; MR
 Mineral Resources..... MR
 Mining districts..... B 507
 Oil, Boulder field..... B 213, 225, 265, 381 d
 De Beque field..... B 531 c
 Florence field..... B 260, 381 d
 Northwestern part..... B 581 a
 Rangely district..... B 350
 Pitchblende ores..... P 90 a
 Radium. See Colorado, carnotite;
 Colorado, pitchblende ores.
 Reservoir sites, Arkansas River.. A 13 iii d
 Silver, Anthracite-Crested Butte dis-
 trict..... GF 9
 Aspen district..... M xxxi

Breckenridge district.....	P 75	269, 286, 287, 288, 289, 306, 307,	
Creede.....	B 530 e	308, 309, 326, 327, 328, 329, 358	
Durango district.....	B 260	Structural materials.....	B 540 k
Empire district.....	P 63	Sulphur, Mineral County.....	B 530 o
Hinsdale County.....	B 470 b, 478	Underground water, Arkansas Val-	
Georgetown district.....	P 63; B 260	ley.....	A 17 ii f; P 52
Idaho Springs district....	P 63; B 285 a	Denver Basin.....	M xxvii
Lake City region.....	B 260, 478	South Platte Valley.....	W 184
La Plata district.....	GF 60	Uranium and vanadium.....	
Leadville district...A 2 d; M xii; B 320		.....	P 90 a; B 262, 315 c, 340 d
Montrose County.....	B 285 b	Vanadium, Placerville region.....	B 530 k
Ouray district.....	B 260; GF 153	Volcanic ash near Durango.....	B 285 c
Rico district.....	A 22 ii c; GF 130	Water, artesian, Apishapa district..	GF 186
Rosita Hills and Silver Cliffs....	A 17 ii b	Water resources.....	W 74
Silverton district..B 182, 315 a; GF 120		San Luis Valley.....	W 240
Telluride district.....	GF 57	Wolframite. See Colorado ferberite.	
Tenmile district.....	GF 48	Zinc, Breckenridge district.....	P 75
Stream measurements.....	W 131, 132,	Creede.....	B 530 e
133, 172, 173, 174, 208, 209, 211,		Colorado formation, fossils.....	B 106
246, 247, 248, 249, 266, 267, 268,			

Geological Folios

Published by the United States Geological Survey Concerning
Colorado Districts.

The following list gives the number of the folio, the district it embraces, and the subjects of which it treats. The folios are for sale by the United States Geological Survey at nominal prices. Copies of them may be seen in the reference library of the Colorado State Bureau of Mines and in the reference rooms of most public libraries. The editions of Nos. 7, 9, 48, 57, and 71 are exhausted:

No.

- 7 Pike's Peak: Gold.
- 9 Anthracite-Crested Butte: Coal, silver, stone, lime, clay.
- 36 Pueblo: Stone, gypsum, clay, iron, underground water.
- 48 Ten Mile District special: Silver.
- 57 Telluride: Gold, silver.
- 58 Elmore: Coal, stone, underground water.
- 60 La Plata: Gold, silver, coal.
- 68 Walsenburg: Coal, stone, clay, underground water.
- 71 Spanish Peaks: Coal, stone, gold, silver, underground water.
- 120 Silverton: Gold, silver, copper, lead, zinc, iron, limestone, building-stone.
- 130 Rico: Gold, silver, zinc, lead, building-stone, lime.
- 131 Needle Mountains: Gold, silver.
- 135 Nepesta: Cement, iron, oil, gas, gravel.
- 153 Ouray: Silver, gold, coal, building-stone, lime.
- 171 Engineer Mountain: Gold, silver, copper, lead, zinc, iron.
- 186 Apishapa: Fire-clay, barite, shale, building-stone, gravel, artesian water.
- In preparation—Castle Rock: Building-stone, limestone, gypsum, sand, clay, gravel, gold.

Mining Districts in Colorado

BOULDER COUNTY

Central (Jamestown): Gold and silver.
Gold Hill: Gold, silver, lead, copper.
Grand Island (Caribou), Eldora: Gold, silver, lead, manganese, copper.
Magnolia: Gold, silver, tungsten.
Nederland: Tungsten.
Sugarloaf: Gold, silver, tungsten, lead, copper.
Ward: Gold, silver, copper, lead.

CHAFFEE COUNTY

Alpine: Lead, gold, silver, copper.
Chalk Creek: Lead, gold, silver, zinc.
Cleora: Copper, gold, silver, zinc, lead.
Cottonwood: Lead, silver.
Granite: Gold, silver, lead, placer.
Hope: Silver, gold, copper, lead.
La Plata (Winfield): Silver, gold, copper, lead.
Monarch-Garfield: Silver, gold, copper, lead, zinc.
Red Mountain: Gold, silver, copper, lead.
Riverside: Gold, silver, lead, copper.
Sedalia: Copper, zinc.
South Arkansas: Iron.
Turrett: Gold, silver, copper.

CLEAR CREEK COUNTY

Argentine: Gold, lead, silver, copper, zinc.
Georgetown (Griffith, Silver Plume, Queens): Silver, zinc, lead, gold, copper.
Idaho Springs (Virginia): Gold, silver, lead, copper, zinc.
Jackson (Corral, Cascade, Democrat): Silver, gold, lead, copper.
Lincoln (Alice, Yankee): Gold, silver, copper, lead (placer).
Montana (Lawson, Dumont): Silver, gold, copper, lead, zinc.
Trail: Lead, gold, silver, copper, zinc.
Upper Union (Empire): Silver, gold, copper, lead.

CONEJOS COUNTY

Ute (Platoro): Gold, silver.
Stunner: Gold, silver.
Wadleigh District: Gold, silver.

COSTILLA COUNTY

Grayback (Russell): Gold (placer).

Plomo: Gold (placer).

CUSTER COUNTY

Hardscrabble (Rosita, Silver Cliff): Silver, gold, lead, copper, zinc.

Oro Verde: Copper, silver.

Spaulding: Lead, gold, silver.

DOLORES COUNTY

Lone Cone (Dunton), west side: Silver, gold, lead, zinc, copper.

Pioneer (Rico), east side: Silver, copper, lead, zinc, gold.

EAGLE COUNTY

Battle Mountain (Red Cliff, Gilman): Silver, zinc, gold, copper, lead.

Eagle: Silver, copper, uranium.

Fulford: Gold, copper, uranium.

Holy Cross (Eagle River): Gold, silver (placer).

FREMONT COUNTY

Cameron: Gold, silver, copper.

Canon City: Copper, tungsten.

Cotopaxi: Copper, zinc, lead.

Currant Creek (Micanite): Zinc (gold, silver).

Greenhorn (Grape Creek): Nickel, cobalt, iron.

Red Gulch: Copper, silver.

Whitehorn (Manoa, Calumet): Gold, silver (copper).

GILPIN COUNTY

Central City: Gold, silver, copper, lead.

Enterprise: Silver, lead, gold, copper.

Eureka: Gold, silver, copper, lead.

Independence (Perigo): Gold, silver, copper, lead.

Illinois Central: Gold, silver, copper, lead.

Central: Gold, silver, copper, lead.

Nevada: Gold, silver, copper, lead.

Gregory: Gold, silver, copper, lead.

Russell: Gold, silver, copper, lead.

Quartz Mountain: Gold, silver, copper, lead.

Lake (Lake Gulch): Gold, silver, lead, copper.

Hawkeye: Gold, silver, lead, copper.

Pleasant Valley: Gold, silver, lead, copper.

Silver Lake: Gold, silver, copper, lead.

Pine (Kingston Apex): Gold, lead, copper, silver.

Vermillion: Gold, silver, copper, lead.

GRAND COUNTY

Grand Lake (Wolverine): Silver, copper, gold, lead.
Harmon: Copper.
La Plata: Gold, silver, copper.

GUNNISON COUNTY

Box Canyon: Silver, gold (copper).
Cebolla (Vulcan, Domingo): Gold, silver, iron.
Cochetopa: Gold, silver.
Elk Mountain (Ruby): Lead, gold, silver.
Gold Brick: Gold, silver, lead.
Quartz Creek: Silver, gold, lead.
Rock Creek: Silver, lead, copper, zinc, gold.
Ruby: Silver.
Tincup (Pieplant): Gold, silver, lead (copper).
Tomichi (Whitepine): Lead, silver, zinc, copper, gold, iron.
White Pine: Lead, gold, silver.
Washington Gulch: Gold, silver, lead, copper.
White Earth: Gold.

HINSDALE COUNTY

Galena: Lead, silver, copper, gold.
Lake (San Cristobal): Silver, gold, lead, copper, zinc.
Park (Sherman): Gold, silver.

HUERFANO COUNTY

Huerfano (Malachite): Copper, silver.
La Veta: Gold, silver.

JEFFERSON COUNTY

Evergreen (Malachite): Copper, silver, gold, nickel.
Golden: Gold (placer).

LAKE COUNTY

California (Leadville): Lead, silver, gold, zinc, copper, iron, manganese.
Twin Lakes: Gold, silver, lead (placer).

LA PLATA COUNTY

California (Oro Fino): Gold, silver, lead, copper.
Needle Mountains (Florida): Gold, silver, copper, lead.

LARIMER AND JACKSON COUNTIES

Empire (Howes Gulch): Copper, gold.
Pearl: Copper (gold, silver).
Pinkhampton: Lead, silver.
Steamboat Rock (Gray Rock): Copper, gold.
Teller (Copper Creek): Lead, silver.

MESA COUNTY

Unaweep: Copper, gold, silver.

MINERAL COUNTY

Sunnyside (Creede): Silver, lead, gold, zinc.

King Solomon: Lead, zinc.

MONTEZUMA COUNTY

East Mancos: Gold, silver.

California: Gold, silver.

Disappointment: Copper, uranium, vanadium.

Blue Mountain: Copper, uranium, vanadium.

MONTROSE COUNTY

Hydraulic: Vanadium, uranium.

La Sal: Copper, silver, vanadium, uranium.

Naturita (Vixen): Vanadium, uranium, copper.

Rock Creek: Vanadium, uranium, copper.

OURAY COUNTY

Imogene Basin (Camp Bird): Gold, silver.

Red Mountain: Copper, silver, gold, lead.

Paquin: Gold, silver, copper, lead.

Sentinel: Gold, silver, copper, lead.

Sneffels: Gold, silver, lead, copper.

Uncompahgre: Gold, silver, lead, copper, zinc.

PARK COUNTY

Buckskin: Gold, silver, copper, lead, zinc.

Consolidated-Montgomery: Gold, silver, lead, copper.

Halls Gulch: Silver (gold).

Hartsel: Gold.

Fairplay: Gold, silver, copper, lead.

Horseshoe: Lead, silver, gold, copper, zinc.

Mosquito: Gold, silver, lead (placer).

Sacramento: Silver, gold, lead (copper).

Tarryall: Gold, silver (placer).

Russia: Gold.

Conrad: Gold.

O'Brien: Gold.

Freshwater: Gold.

Black Mountain: Gold.

Beaver Creek: Gold (placer).

Red Ruth: Gold.

Cover Mountain: Gold.

Alhambra: Gold.

Hartzel: Gold, uranium, vanadium.

PITKIN COUNTY

Columbia (Ashcroft): Lead, silver, copper, iron.
Dry Pine: Gold, silver, lead, copper.
Frying Pan: Lead, gold, silver, copper.
Lincoln: Silver, lead, gold.
Roaring Forks (Aspen): Lead, silver, zinc, copper.
Woody: Gold, silver, copper.
Highland: Gold, silver, lead, copper.
Independence: Gold, silver, lead, copper.

PUEBLO COUNTY

Beulah: Gold, silver.

RIO BLANCO COUNTY

Coal Creek: Vanadium, uranium.

RIO GRANDE COUNTY

Decatur (Jasper): Gold, silver.
Embargo: Gold, silver, lead, copper.
Summitville: Gold, silver.
Coon: Gold, silver.
Meyers Creek: Gold, silver.
Sumner: Gold, silver.
Elwood: Gold, silver.
Cat Creek: Gold, silver.

ROUTT AND MOFFAT COUNTIES

Copper Ridge: Copper, gold.
Four Mile: Placer.
Elkhorn (Three Forks, Slatter): Copper, lead, silver, gold.
Hahns Peak (Columbine): Gold, silver, lead, zinc (placer).
Lay (Jack Rabbit): Gold (placer).
Oak Creek (Red Gorge): Copper.
Rabbit Ears: Lead, silver.
Farwell: Copper, silver, gold.
Rock Creek (Gore Range): Copper.
Skull Creek (Blue Mountain): Vanadium, uranium, copper.
Slavonia: Lead (silver, copper, gold).
Spring Creek (Steamboat Springs): Copper, gold.
Whiskey Park: Lead, copper, silver.
Three Forks: Lead, silver, gold.
Grand Encampment: Lead, silver, gold.
Douglas Mountain: Copper.

SAGUACHE COUNTY

Baca Grant (Crestone): Gold, silver.
Blake (Kerber Creek): Lead, silver, gold (copper).
Crystal Hill: Silver, gold.
Cochetapa: Gold, silver.
Manitou: Gold, silver.
Meyers Creek: Gold, silver.
Music: Gold, silver.
Orient: Iron.

SAN JUAN COUNTY

Animas: Gold, silver, copper, lead, zinc.
Eureka: Gold, silver, lead, copper, zinc.
Red Mountain: Gold, silver, lead, copper, zinc.
Anvil Mountain: Gold, silver, lead, copper, zinc.
Ice Lake: Gold, silver, lead, copper, zinc.
San Juan: Gold, silver, lead, copper, zinc.

SAN MIGUEL COUNTY

Iron Spring (Ophir): Gold, silver, lead, copper.
Norwood District: Gold, silver, lead, copper, vanadium.
Lower San Miguel (Placerville, Sawpit, Newmire): Gold, silver, lead, copper, vanadium (placer).
Mount Wilson: Silver, gold, lead, copper.
Snyderville (Cedar): Vanadium, uranium.
Upper San Miguel (Telluride): Gold, silver, lead, copper, zinc.

SUMMIT COUNTY

Breckenridge (Bevan, Union, Minnesota): Gold, zinc, lead, silver (placer).
Frisco: Gold, silver (lead, zinc).
Montezuma (Snake River): Lead, silver, copper, zinc, gold.
Pollock District: Gold, silver, lead, zinc.
Peru: Silver, lead, gold.
Swan River: Gold (placer).
Tenmile (Kokomo): Silver, gold, lead, zinc, copper.
Bald Mountain: Gold, silver, lead, zinc.
Spaulding: Placer.
Wilkinson: Placer.
Salt Lick: Placer.

TELLER COUNTY

Cripple Creek: Gold, silver.
East Beaver: Copper, gold, silver.

Labor Troubles

There have been no serious disagreements between capital and labor in the Colorado metal-mining industry in the last ten years.

The coal strike, which had been in progress four years and was called off in December, 1914, was confined to that industry.

The trainmen of the Cripple Creek Short Line railroad entered upon a strike in the spring of 1914, which threatened to close the mines of the Cripple Creek district, dependent upon that railroad for a supply of coal. The strike was settled in a few days, without loss of time to any of the mines.

Accidents

The very nature of the employment makes it impossible to eliminate accidents in mining, but, with reasonable effort, their frequency can be controlled. This department has labored to make the metal mines of Colorado as safe as possible, and we have had the co-operation of the mine operators. The state laws regulate the operation and equipment of mines, and these regulations are sufficient to cover every case.

There were few accidents, if any, occurring during the last two years, which might be charged to the gross negligence of the operator, both because this department has made every effort to enforce the laws, and also because the operators desire to co-operate. On the other hand, there is a comparatively large number of accidents that can be charged to the carelessness of the employe.

Pride is the occasion of not a few avoidable accidents. A workman who is warned to be careful sometimes loses his temper and takes chances which he should not take, because he does not want a fellow-employe to "tell him his business." Lack of judgment, or rather precipitate judgment, is another frequent occasion of avoidable accidents. It is especially true that pride and precipitate judgment are the occasion of many accidents resulting from falling ground and from explosives.

It is impossible to eliminate accidents at the working face, where the ground is exposed, and therefore the most exacting vigilance on the part of the miner is necessary. Miners must be taught to take no chances. Careless employes should be discharged before they bring disaster to themselves and others.

Timbering should be carried forward as close as practicable to the working face of drifts, so that at the least warning of danger a miner may step back to safety.

Miners should not wander far from their accustomed stations without a good light to guide their feet. The law requires that all openings of winzes, upraises, and manholes be kept covered, but a careless workman may leave one open, trusting to luck that no one will come along or that the opening will be seen.

Miners working on staging should satisfy themselves that it is safe beyond the point merely of sustaining their own weight. A loose rock may crush the staging and send them falling to their death below.

When handling loose ore in shoots or bins, the employe should consider his own safety first and take no chances with this source of danger.

Foul air and powder smoke also are causes of accidents. We do not have great disasters, as in coal mines; for the air in metal mines is usually wholesome; but occasionally gas exists in parts of some mines. The miner should take heed of the first warning and seek safety until the air is purified.

The machinery, shafts, ventilation, fire protection, storage of powder, character and condition of tools and machines employed in and about the mines, etc., are subjected to rigid inspection by this department. Our inspectors have large territories to cover, but they endeavor to visit each mine in their territory once a year, and oftener if necessary. Whenever even the slightest defect is discovered, orders are given to make repairs or alterations immediately.

Complaints by employes regarding the condition of mines are treated as confidential, and carefully investigated.

ACCIDENTS

CAUSE OF ACCIDENT.

ABOVE GROUND	1913		1914†	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Machinery accidents.....	1	8		5
Mill and dredge.....	5	51	1	2
Smelter accidents*.....	1	336	2	335
Overwinding cage or bucket.....				
Falling from gallows frame or staging.....		4		
Gravity tram.....	1	1		
Tramming, coupling or dumping cars.....	1	7		7
Handling loose rock or ore.....		3		2
Falls while carrying tools or material.....				
Snowslide.....				
Getting on or off cage or bucket at surface.....				
Falls in chute or bin or caught with running ore.....		1		2
Falling into uncovered prospect hole.....				
Operating hydraulic machine.....				
Injured by windlass.....			1	
Miscellaneous.....		9	1	14
Electricity.....			1	
TOTAL.....	9	420	6	367

SHAFT ACCIDENTS	1913		1914	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Getting on or off cage or bucket in motion at station.....		2		
Falls from bucket or cage while being hoisted or lowered.....	2	1		1
Caught in shaft while being hoisted or lowered.....	2	4	5	2
Falls from ladder.....		1		
Material falling from level or side of shaft.....	1	3		2
Struck by descending cage or bucket.....		2		2
Pushing car into open shaft, going down with same.....				
Falls of rock or earth in shaft.....				1
Falling down shaft from level.....	1	1	2	
Material falling from overloaded bucket.....	1			2
Cable becoming detached, letting cage down shaft.....		1	1	3
Miscellaneous.....		6		3
TOTAL.....	7	21	8	16

*Prior to 1912 smelters did not report accidents to this department.

†Includes only first eleven months of 1914 to November 30, 1914.

ACCIDENTS—Concluded

UNDERGROUND ACCIDENTS	1913		1914*	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Falls of rock.....	23	83	17	59
Falls of timber while timbering.....		7		2
Falls from ladder.....	1	7		2
Falls from staging while working.....	1	11	1	3
Falls in chute, winze, upraise or manway.....	4	8	5	7
Caught in chute with running ore.....		2	1	4
Injured by tram car.....	1	29		20
Struck by flying rock or steel from hammer or pick...		4		2
Struck with hammer, pick or tools.....		5		6
Injured handling loose rock or ore.....		9		16
Falls while carrying tools or material in mine.....		2		
Suffocation, burning shaft-house or tunnel building...				
Suffocation, bad air or powder smoke.....	3	1	5	5
Operating machine drill.....		6		1
Miscellaneous.....		11	1	13
Electricity.....		2		2
TOTAL.....	33	187	30	142

EXPLOSIVES	1913		1914	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Thawing powder over candle, in stove, hot water or sand.....				
Picking out missed shot.....	1	3		
Drilled into hole that missed fire.....		3	1	1
Blast exploded while loading.....		1		
Remaining too long after lighting fuse.....		1	1	1
Returned before blast exploded.....				
Struck unexploded powder or caps with pick or shovel while cleaning away muck.....		1		
Hit with flying rock from blast, not being in place of safety.....				
Explosion, cause unknown.....		1		
Miscellaneous.....		3		4
TOTAL.....	1	13	2	6
GRAND TOTAL.....	50	641	46	531

*Includes only first eleven months of 1914 to November 30, 1914.

NUMBER ENGAGED IN MINING, MILLING, AND SMELTING

COUNTY	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
Archuleta	18	7	10	4	6	12	8	10	14	12	13	23	25
Boulder	1,556	1,310	1,087	975	1,042	1,076	1,050	823	746	423	522	705	745
Chaffee	725	470	680	742	615	820	780	576	532	390	423	670	673
Clear Creek	2,010	1,748	1,936	1,360	1,985	2,036	2,050	938	854	843	861	863	808
Conejos	18	20	15	6	4	7	8	6	8	14	18	312	235
Costilla	35	30	32	10	14	12	14	7	9	15	19	21	19
Custer	350	566	625	647	521	464	480	216	187	163	197	196	201
Delta	5	10	12	8	6	9	11	8	7	.....	.....	9	14
Denver	.....	.....	1,175	1,210	1,175	1,060	1,042	914	873	455	475	561	589
Dolores	352	325	378	418	396	337	365	125	95	93	158	155	153
Douglas	7	5	7	3	7	14	12	8	7	35	44	35	35
Eagle	305	240	265	340	376	384	350	182	153	112	215	285	220
El Paso	830	792	742	518	785	797	940	942	928	935	918	400	400
Fremont	725	630	768	610	630	563	586	220	45	70	105	110	112
Garfield	15	12	20	10	15	20	18	12	10	12	16	15	14
Gilpin	2,322	1,985	1,860	1,990	1,837	1,971	1,940	876	741	888	876	940	935
Grand	75	90	100	36	28	116	145	38	46	55	80	83	81
Gunnison	630	537	687	590	672	642	630	374	498	270	215	218	229
Hinsdale	580	332	420	432	395	408	370	187	162	98	114	105	95
Huerfano	35	10	12	8	12	11	10	.....	.....	37	68	15	18
Jefferson	85	52	115	185	76	76	84	63	58	65	67	30	30

	5,772	6,300	6,380	6,425	6,911	5,906	5,836	2,630	2,460	2,555	2,770	2,776	2,982
Lake.....	475	525	784	792	642	640	625	427	630	390	264	312	285
La Plata.....	45	82	85	77	96	126	108	10	14	18	21	12	10
Larimer.....	920	918	1,010	873	964	872	866	618	526	215	232	198	193
Mineral.....	152	110	132	80	75	76	64	.....	.....	141	168	367	390
Montrose.....	65	35	146	168	210	140	162	.....	.....	60	85	50	25
Mesa.....	143	190	185	170	148	135	125	78	106	109	113	13	18
Montezuma.....	1,609	1,465	1,586	1,626	1,510	1,468	1,430	867	752	684	687	703	726
Ouray.....	1,485	1,500	1,945	1,744	1,867	1,832	1,684	1,620	1,684	5,822*	5,850*	5,606*	5,589*
Pueblo.....	406	420	635	690	682	586	570	482	476	153	74	93	104
Park.....	1,355	900	1,252	1,035	1,108	980	916	628	538	206	387	298	263
Pitkin.....	25	12	10	11	15	12	14	15	18	15	24	23	23
Rio Blanco.....	145	110	131	120	94	74	86	22	27	68	87	95	93
Rio Grande.....	135	200	233	190	217	186	232	116	132	85	110	115	205
Routt.....	310	280	385	375	348	274	295	137	119	108	101	140	129
Saguache.....	1,595	1,647	1,860	1,740	1,836	1,890	1,756	872	743	705	851	803	820
San Juan.....	1,625	1,250	1,190	1,233	1,320	1,640	1,460	1,084	1,142	1,333	1,237	1,336	1,505
San Miguel.....	623	570	814	860	851	580	615	310	455	342	511	492	498
Summit.....	5,940	5,200	5,667	5,480	5,196	4,762	4,983	3,861	3,743	3,815	4,028	3,900	3,860
Teller.....	35,118	32,267	35,376	34,287	34, 90	33,014	32,720	20,302	19,568	21,809	23,004	23,077	22,409
TOTAL.....													

*Includes employees of C. F. & I. Co. plant and two smelters.

EMPLOYEES ABOVE AND UNDER GROUND

	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
Number of men engaged above ground	14,150	13,754	13,916	13,041	12,854	7,840	7,626	7,905	7,801	7,877	7,886
Number of men engaged under ground	21,226	20,533	20,874	19,973	19,866	12,462	11,942	13,904	15,203	15,200	14,523
Total number engaged in mining, milling and smelting	35,376	34,287	34,790	33,014	32,720	20,302	19,568	21,809	23,004	23,077	22,409
Number of non-fatal accidents.....	539	486	436	300	313	347	274	247	435*	641*	531*
Number of fatal accidents.....	101	109	82	77	64	51	51	43	47	50	46
Non-fatal accidents above ground.....	105	103	72	43	45	80	79	52	225*	420*	367*
Fatal accidents above ground.....	13	11	12	17	5	11	6	6	5	9	6
Non-fatal accidents under ground.....	434	383	364	257	230	207	195	195	210	221	164
Fatal accidents under ground	88	98	70	60	48	40	45	37	42	41	40

*Includes smelter and dredge accidents which were not reported to this department prior to 1912.

Safety Recommendations

DURING THE FISCAL YEARS OF 1913 AND 1914 THE FOLLOWING RECOMMENDATIONS WERE MADE BY THE DEPARTMENT:

	1913	1914
Regarding timbers.....	15	13
Regarding explosives.....	18	12
Regulating amount of powder kept in storage.....	5	3
Use of steel or iron tamping bar.....	3	1
Removing old timbers from mine.....	9	5
Regarding employment of hoisting engineer.....	6	4
Regarding indicator on hoisting machinery.....	12	9
Posting uniform code of signals.....	40	46
Regarding fire protection.....	13	14
Timbering shafts, stopes, raises and securing same.....	25	29
Partitioning shafts or divide into compartments.....	5	8
Placing ladders in shaft, with stations as law provides.....	10	9
Provide or repair ladders in upraise or winzes-manway.....	18	21
Provide tunnel or adit with connection to surface with suitable ladders, as provided by law.....	4	5
Provide chain ladders in shaft or incline when sinking.....	2	.....
Provide shaft collar with cover, bonnet or doors.....	1	2
Equip cage with safety clutches or repair same.....	5	5
Make passageway around working shaft.....	1	.....
Provide guard rails at shaft stations.....	7	4
Cover winzes or mill holes, or surround with guard rails.....	11	13
Leave pillar ground standing on side of shaft.....	.....	.....
Cover or fence abandoned mine shafts or pits.....	11	14
Notice of number of men permitted to ride upon cage, skip or bucket.....	25	35
Repair cable, or replace cable, or test cable.....	5	7
Repair machinery.....	3	4
Place fire doors near mouth of tunnel and in shafts.....	10	9
Regarding sanitary conditions.....	4	3
Provide chairs or overwinding device.....	2	2
Miscellaneous.....	19	21
Electricity, electric wire, etc.....	5	6

Instructions for Resuscitation from Electric Shock

(Recommended by a commission representing the American Medical Association, the National Electric Light Association, and the American Institute of Electrical Engineers. Issued and copyrighted by the National Electric Light Association, Engineering Societies Building, New York.)

TREATMENT FOR ELECTRIC SHOCK

An accidental electric shock usually does not kill at once, but may only stun the victim and for a while stop his breathing.

The shock is not likely to be immediately fatal, because:

(a) The conductors may make only a brief and imperfect contact with the body.

(b) The skin, unless it is wet, offers high resistance to the current.

Hope of restoring the victim lies in prompt and continued use of artificial respiration. The reasons for this statement are:

(a) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(b) If the body is not thus repeatedly supplied with air, suffocation occurs.

(c) Persons whose breathing has been stopped by electric shock have been reported restored after artificial respiration has been continued for approximately two hours.

The Schafer, or "prone pressure," method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(a) Easy performance; little muscular exertion is required.

(b) Larger ventilation of the lungs than by the supine method.

(c) Simplicity; the operator makes no complex motions and readily learns the method on first trial.

(d) No trouble from the tongue falling back into the air passage.

(c) No risk of injury to the liver or ribs, if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

METHOD OF RESUSCITATION

Follow these Instructions Even if Victim Appears Dead

I. Break the Circuit Immediately

1. With a single quick motion separate the victim from the live conductor. In so doing, avoid receiving a shock yourself. Many have, by their carelessness, received injury in trying to disconnect victims of shock from live conductors.

OBSERVE THE FOLLOWING PRECAUTIONS

(a) Use a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the wire, so as to break the electrical contact. Beware of using metal or any moist material. The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous.

(b) If the body must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting, or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only *one* hand.

If the victim is conducting the current to ground, and is convulsively clutching the live conductor, it may be easier to shut off the current by lifting him than by leaving him on the ground and trying to break his grasp.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle, or properly insulated pliers.

II. Send for the Nearest Doctor

This should be done without a moment's delay, as soon as the accident occurs, and while the victim is being removed from the conductor.

The doctors entered on the following page are recommended :

Name

Address

Telephone Call

Name

Address

Telephone Call

Name

Address

Telephone Call

Name

Address

Telephone Call

III. Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat, and remove any foreign body (tobacco, false teeth, etc.). *Then begin artificial respiration at once.* Do not stop to loosen the patient's clothing; *every moment of delay is serious.*

2. Lay the subject on his belly, with arms extended as straight forward as possible, and with the face to one side, so that the nose and mouth are free for breathing (see Figure 1). Let an assistant draw forward the subject's tongue.

If possible, avoid so laying the subject that any burned places are pressed upon.

Do not permit bystanders to crowd about and shut off fresh air.

3. Kneel, straddling the subject's thighs and facing his head; rest the palms of your hands on the loins (on the muscles of the small of the back), with thumbs nearly touching each other, and with fingers spread over the lowest ribs (see Figure 1).

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject (see Figure 2). This operation, which should take from two to three seconds, *must not be violent*—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

5. Now *immediately* swing backward so as to remove the pressure, but leave your hands in place, thus returning to the position shown in Figure 1. Through their elasticity, the chest walls expand, and the lungs are thus supplied with fresh air.

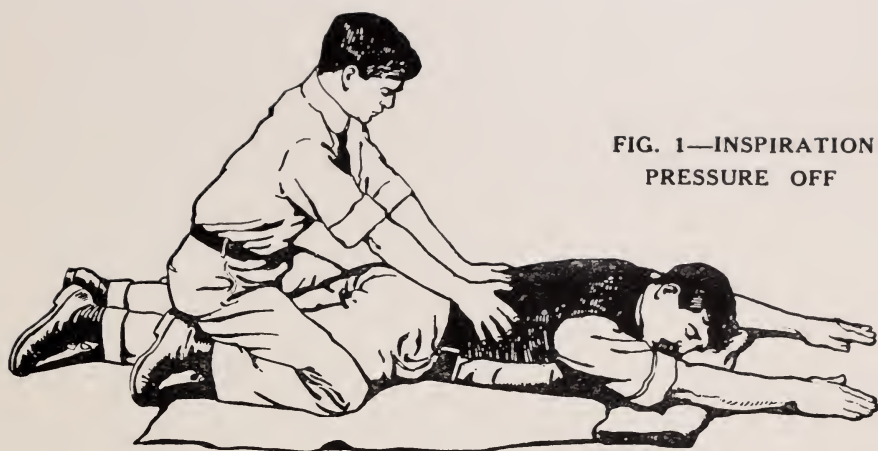


FIG. 1—INSPIRATION;
PRESSURE OFF

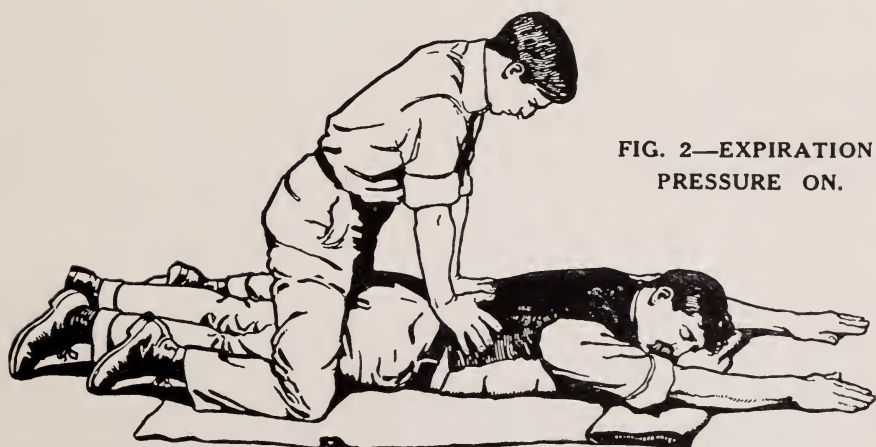


FIG. 2—EXPIRATION;
PRESSURE ON.

6. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing—swinging forward with each expiration, and backward with each inspiration.

While this is being done, an assistant should loosen any tight clothing about the subject's neck, chest, or waist.

7. Continue artificial respiration (if necessary, two hours or longer), *without interruption*, until natural breathing is restored or until a physician arrives. Even after natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with *warm* (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

8. *Do not give any liquids whatever by mouth until the subject is fully conscious.*

First Care of Burns

When natural respiration has been restored, burns, if serious, should be attended to until a doctor comes.

A raw or blistered surface should be protected from the air.

If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent). If this is not at hand, use a solution of baking-soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water. Or it may be protected with a heavy oil, such as machine oil, transformer oil, vaseline, linseed, carron or olive oil. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchiefs, or other soft cloth, held lightly in place by a bandage.

The same coverings should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.

“Don’ts” for the Operators, Mine Managers, Superintendent, Miners, and Engineers

FOR OPERATORS AND MINE MANAGERS

Don’t forget that the mine inspector is an officer of the law.
Don’t omit to report all accidents.

Don’t forget that two places of egress are required at all mines.

Don’t say that you are ignorant of the mining law.

Don’t fail to provide sufficient timbers at your mine for timbering.

Don’t fail to protect the lives of all of your employes.

Don’t fail to make annual report on your property to the Bureau of Mines on November 1 of each year for the twelve months preceding.

FOR MINE SUPERINTENDENTS

Don’t let your signaling device get out of order.

Don’t allow men to ride on the cage when safety catches are out of order.

Don’t fail to provide sufficient hand rails or rings on the cage.

Don’t let a day pass without having safety catches tested.

Don’t fail to have hoisting rope tested before men are lowered into the mine.

Don’t omit to do whatever is necessary for the safety of your employes.

Don’t allow material to be hoisted while men are on the cage.

Don’t fail to scrap for your rights and those of the company you are working for.

Don’t forget to have your powder thawed outside of your shaft-house and have a building for this purpose.

Don’t drive cross-cuts or drifts on a grade of over four and one-half inches to the hundred feet. By driving on this grade, it will take the same power to haul the empty car back that it takes to haul the loaded car out.

Don't forget to leave a solid block of ground not less than twenty-five feet on either side of your working shaft.

Don't let your temper get hot enough to be incandescent.

Don't fail to give proper credit for work well done.

Don't forget that kind words to your employes cost you nothing.

Don't forget to have a kind word for the miner who is seeking employment.

FOR MINERS

Don't forget that "liberty" consists in the power of doing that which is permitted by law.

Don't fail to understand the difference between self-reliance and self-sufficiency.

Don't drill into missed holes.

Don't forget to use wooden tamping bars.

Don't fail to have your working place sufficiently timbered.

Don't forget your fellow-miners at the time of danger.

Don't fail to protect the company's property.

Don't fail to comply with the rules of the company and the instructions of the mine superintendent.

FOR HOISTING ENGINEERS

Don't forget that the men on the cage have no control over their own fate, and they depend upon your skill and attention while being hoisted and lowered into the mine.

Don't let your signal device get out of order.

Don't fail to have a good brake on the hoisting drum.

Don't neglect your cable fastenings.

Don't forget the code of signals.

Don't start the engine until you get the correct signal.

Don't fail to keep hoisting ropes in good condition.

Don't get excited when you have an accident. Keep cool.

Don't forget the lawful speed at which men should be hoisted or lowered into the mine.

Don't talk to anyone while you are operating the engine.

Code of Signals

The following is a certified copy of the state code of bell signals for all metalliferous mines operating in the State of Colorado, from Level No. 1 to Level No. 30, inclusive; by order of T. R. Henahan, Commissioner of Mines:

1-1	Bells	1st	Level
1-2	Bells	2nd	Level
1-3	Bells	3rd	Level
1-4	Bells	4th	Level
1-5	Bells	5th	Level
2-1	Bells	6th	Level
2-2	Bells	7th	Level
2-3	Bells	8th	Level
2-4	Bells	9th	Level
2-5	Bells	10th	Level
4-1	Bells	11th	Level
4-2	Bells	12th	Level
4-3	Bells	13th	Level
4-4	Bells	14th	Level
4-5	Bells	15th	Level
5-1	Bells	16th	Level
5-2	Bells	17th	Level
5-3	Bells	18th	Level
5-4	Bells	19th	Level
5-5	Bells	20th	Level
6-1	Bells	21st	Level
6-2	Bells	22nd	Level
6-3	Bells	23rd	Level
6-4	Bells	24th	Level
6-5	Bells	25th	Level
8-1	Bells	26th	Level
8-2	Bells	27th	Level
8-3	Bells	28th	Level
8-4	Bells	29th	Level
8-5	Bells	30th	Level

Financial Statement of the Bureau of Mines, 1913-1914

APPROPRIATIONS.

Salaries.....	\$24,800	
Traveling expenses of Commissioner and four inspectors.....	10,000	
Incidental fund.....	1,500	
		\$36,300
Fees collected.....		23
		\$36,323

DISBURSEMENTS.

	Salary	Expenses	Incidental	Total
Commissioner.....	\$ 5,000.00	\$ 1,996.40		
Inspectors.....	14,400.00	6,677.88		
Chief clerk.....	3,000.00			
Stenographer.....	2,333.32			
Incidental.....			\$ 1,442.15	
	\$24,733.32	\$ 8,674.28	\$ 1,442.15	\$34,849.75
Balance.....	66.68	1,325.72	57.85	1,450.25
*Fees remitted to State Treasurer.....				23.00
Total balance.....				\$ 1,473.25

*The only fees collected by this department are those for making certified copies of records.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES, THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1913.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Name of County											
Boulder	2,780.261	\$ 57,467.99	113,137.65	\$ 67,646.13	516.331	\$ 22,563.66	33,246	\$ 5,051.40	.....	.....	\$ 152,729.18
Chaffee	14,357.903	296,777.86	158,954.35	95,040.40	3,266.030	142,725.51	350,021	53,182.19	844,897	46,503.13	634,229.09
Clear Creek	23,776.654	491,463.44	483,675.77	289,194.58	5,038.643	220,188.70	571,490	86,832.19	837,012	46,069.14	1,133,748.05
Custer	707.277	14,619.42	11,169.50	6,678.36	5.920	258.70	4,265	648.02	.....	.....	22,204.50
Concejo	.571	11.80	4.04	2.42	.....	.....	.....	.....	.....	.....	14.22
Dolores	702.452	14,519.68	200,151.57	119,672.63	2,945.298	128,709.52	1,181,866	179,572.72	1,201,837	66,149.12	508,623.67
Douglas	18.718	386.90	183.55	109.75	.....	.....	14,326	2,176.69	.....	.....	2,673.34
Eagle	2,069.060	42,767.47	348,582.51	190,483.67	1,534.814	67,071.37	46,902	7,126.29	9,918,455	545,911.76	853,300.56
El Paso	.....	.....	.....	.....	.....	.....	8,505	1,292.25	.....	.....	1,292.25
Fremont	4,431	91.59	62.03	37.09	.....	.....	3,744	568.86	.....	.....	697.54
Garfield	43,589	900.98	121.55	72.68	.....	.....	13,717	2,084.16	.....	.....	3,057.82
Gilpin	30,651.769	633,572.07	287,993.27	172,194.06	1,380,465	60,326.32	881,963	134,005.46	.....	.....	1,000,097.91
Gunnison	494.410	10,219.45	85,444.79	51,088.29	176,041	7,692.99	14,630	2,222.88	32,328	1,779.33	73,002.94
Hinsdale	250.360	5,174.94	29,549.34	17,667.85	891,405	38,954.40	74,366	11,299.17	44,163	2,430.73	75,527.09
Huerfano	.280	5.79	.06	.03	.....	.....	.....	.....	.....	.....	5.82
Jefferson	.....	.....	4.61	2.76	90	3.93	719	109.25	.....	.....	115.94
La Plata	15,146.128	313,070.47	121,248.43	72,495.65	4,559	199.23	113,893	17,304.90	.....	.....	403,070.25
Larimer	.....	.....	502.14	300.23	.....	.....	.....	.....	.....	.....	300.23
Lake	50,339.814	1,040,523.95	3,196,794.70	1,911,395.52	23,938,857	1,046,128.05	2,279,221	346,304.84	88,478,790	4,869,872.60	9,214,224.96

[illegible]

NOTE.—In above table the calculations are based on the average price of the mineral for the year. Gold, \$20.67; silver, 0.59791; lead, 0.0437 a pound; copper, 0.15194 a pound; zinc, 0.05504 a pound; tungsten, \$7.50 a unit; uranium ore, \$100 a ton; vanadium ore, \$100 a ton. Radium is obtained from the oxide of uranium.

Tungsten, Boulder County production 1913, 938 tons, \$450.00 per ton	\$ 422,100 00
Uranium Ore, Gilpin County's production 1913, 1324 tons	120,000 00
Uranium Ore, Montrose County's production 1913, 1,870 tons	187,000 00
Vanadium Ore, San Miguel County production 1913, 1,764 tons	176,400 00

(Left Blank for 1914 Output Table to Be Furnished)

(Left Blank for 1914 Output Table to Be Furnished)

THE BUREAU OF MINES OF THE STATE OF COLORADO
PRECIOUS METAL PRODUCTION OF COLORADO TO DECEMBER 31, 1912.

YEAR	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Previous to 1870	1,316,550	\$27,213,081 00	250,000	\$ 330,000 00			200,000	\$ 40,000 00			\$ 27,583,081 00
1870	145,864	5,015,000 00	500,000	660,000 00			97,088	20,000 00			3,695,000 00
1871	175,808	3,633,951 00	779,590	1,029,055 00			90,909	30,000 00			4,693,009 00
1872	128,034	2,646,463 00	1,594,207	2,015,001 00			155,172	45,000 00			4,711,464 00
1873	88,788	1,835,248 00	1,683,370	2,185,014 00	80,000	\$ 5,000 00	28,172	65,000 00			4,092,340 40
1874	99,932	2,065,595 00	2,415,435	3,086,926 00	112,000	7,078 40	400,876	90,197 00			5,280,220 40
1875	112,291	2,321,055 00	2,306,253	2,873,591 00	624,000	37,502 40	428,571	90,000 00			5,380,352 00
1876	131,897	2,726,311 00	2,552,125	2,950,256 00	1,334,000	81,774 20	376,244	70,000 00			5,828,341 20
1877	145,138	3,000,000 00	3,480,548	4,180,138 00	1,704,000	98,490 60	504,283	93,796 64			7,372,425 24
1878	162,864	3,366,404 00	4,172,744	4,807,001 00	13,338,000	481,501 80	539,393	89,000 00			8,743,906 80
1879	156,023	3,225,000 00	9,049,424	10,162,503 00	47,348,000	1,960,207 20	766,082	131,000 00			15,478,710 20
1880	154,814	3,200,000 00	13,148,735	15,055,302 00	71,348,000	3,595,939 20	915,422	184,000 00			22,035,241 20
1881	159,652	3,300,000 00	13,272,488	15,104,092 00	81,094,000	3,900,621 40	899,503	161,000 00			22,465,713 40
1882	162,554	3,360,000 00	12,707,866	14,436,136 00	110,000,000	5,401,000 00	1,494,000	276,390 00			23,473,526 00
1883	198,355	4,100,000 00	13,434,915	14,912,756 00	141,114,000	6,096,124 80	1,153,000	182,750 50			25,291,631 30
1884	205,612	4,280,000 00	12,375,280	13,984,066 00	126,330,000	4,724,742 00	2,013,000	278,800 50			23,237,608 50
1885	203,193	4,200,000 00	12,220,589	13,014,927 00	111,000,000	4,345,000 00	1,146,000	127,435 20			21,087,362 20
1886	215,288	4,450,000 00	12,375,280	12,313,404 00	118,000,000	5,463,400 00	409,000	44,990 00			22,271,794 00
1887	193,517	4,000,000 00	11,600,826	11,345,608 00	126,000,000	5,670,000 00	2,012,000	226,350 00			21,241,958 00
1888	181,809	3,758,000 00	14,695,645	13,813,906 00	131,000,000	5,790,200 00	1,621,000	270,058 60			23,632,164 60
1889	187,898	3,833,859 00	18,375,519	17,199,486 00	138,000,000	5,423,400 00	3,100,000	426,250 00			26,632,995 00

1890	200,774	4,150,000.00	18,800,425	19,665,245.00	109,000,000	4,883,200.00	6,000,000	945,000.00	.....	.....	29,643,445.00
1891	222,545	4,400,000.00	21,160,480	20,906,554.00	128,000,000	5,568,000.00	7,000,000	883,400.00	.....	.....	31,957,954.00
1892	256,410	5,300,000.00	26,350,000	23,082,600.00	123,000,000	5,030,700.00	7,250,000	837,375.00	.....	.....	34,250,675.00
1893	364,151	7,527,000.00	25,838,000	20,205,785.00	84,396,000	3,147,970.80	7,121,157	765,535.13	.....	.....	31,646,290.93
1894	462,009	9,549,731.00	23,236,025	14,638,696.00	97,264,000	3,200,000.00	6,528,214	624,097.26	.....	.....	28,012,524.26
1895	656,021	13,559,954.00	17,891,026	11,683,232.00	91,477,214	2,954,714.00	6,125,000	659,050.00	.....	.....	28,856,950.00
1896	738,618	15,267,234.00	21,547,743	14,458,536.00	82,018,000	2,321,109.30	7,539,245	820,269.86	.....	.....	32,867,149.26
1897	947,249	19,579,637.00	21,278,202	12,692,448.00	80,799,778	2,731,032.49	9,151,592	900,917.13	.....	.....	35,904,034.62
1898	1,138,584	23,534,531.28	23,562,601	13,690,265.15	113,417,168	4,117,043.24	10,870,869	1,304,504.28	.....	.....	42,646,343.95
1899	1,282,471	26,508,675.57	23,114,088	13,771,731.10	138,048,446	6,170,765.53	7,357,245	1,295,610.85	.....	.....	47,746,783.05
1900	1,391,487	28,762,036.29	20,336,712	12,488,774.84	164,274,762	7,770,196.24	7,826,949	1,203,011.98	.....	.....	50,314,019.35
1901	1,339,112	27,679,445.04	18,492,563	10,901,365.89	148,111,020	6,419,131.61	7,872,529	1,303,297.17	.....	.....	46,303,239.71
1902	1,379,638	28,517,117.46	15,941,703	8,315,192.29	106,303,374	4,325,484.29	8,463,938	1,006,108.31	.....	.....	44,708,805.83
1903	1,045,252	21,605,358.84	13,245,483	7,079,710.66	101,513,414	4,301,123.35	7,809,920	1,033,642.90	.....	.....	38,373,099.75
1904	1,171,892	24,223,007.64	12,960,777	7,416,156.60	107,546,854	4,624,514.73	9,401,913	1,205,607.31	.....	.....	40,783,074.25
1905	1,237,443	25,577,946.81	12,831,348	7,743,718.51	115,712,908	5,433,506.67	9,854,176	1,536,266.04	.....	.....	45,070,935.94
1906	1,092,827	22,588,734.09	12,728,882	8,499,734.83	105,984,540	5,666,993.36	9,505,319	1,844,002.19	.....	.....	43,898,075.56
1907	990,398	20,471,526.66	12,059,202	7,886,736.17	92,987,235	4,965,517.10	11,256,291	2,251,258.20	.....	.....	40,847,834.55
1908	1,097,995	22,695,575.75	9,416,025	4,975,428.05	57,711,898	2,429,670.91	10,644,099	1,333,732.87	.....	.....	33,283,010.91
1909	1,061,663	21,946,684.13	8,908,045	4,587,643.34	64,720,046	2,765,511.72	10,087,950	1,220,641.95	.....	.....	33,211,527.32
1910	981,980	20,297,535.69	8,215,327	4,392,735.72	70,565,369	3,158,380.54	8,304,312	1,048,834.60	.....	.....	32,263,923.74
1911	921,274	19,042,741.70	7,356,837	3,921,414.75	65,518,399	2,925,396.51	9,379,945	1,146,135.46	.....	.....	32,731,866.19
1912	904,285	18,691,577.26	8,258,339	5,023,900.75	73,377,379	3,280,702.62	8,886,121	1,445,416.44	.....	.....	37,033,280.80
1913	878,021	18,148,711.27	9,223,975	5,515,107.32	85,040,063	3,716,250.75	8,167,049	1,240,901.43	.....	.....	34,839,577.49
TOTAL	26,287,980	\$543,375,018.48	555,913,387	\$439,001,951.32	3,626,940,467	\$155,089,603.86	220,803,548	\$30,996,634.80	.....	.....	\$1,222,383,355.90

NOTE.—In the above table the calculations are made on the average of the mineral for the year.

Average Market Value of Metals per Annum

YEAR	Gold per Ounce	Silver per Ounce	Lead per Pound	Copper per Pound	Zinc per Pound
Previous to 1870.	\$20.67	\$1.32	.....	\$0.20	.....
1870.....	20.67	1.32	.....	.206	.....
1871.....	20.67	1.32	.....	.33	.....
1872.....	20.67	1.322	\$0.0625	.29	.....
1873.....	20.67	1.298	.0632	.232	.....
1874.....	20.67	1.278	.0601	.225	.....
1875.....	20.67	1.246	.0585	.21	.....
1876.....	20.67	1.156	.0613	.186	.....
1877.....	20.67	1.201	.0549	.186	.....
1878.....	20.67	1.152	.0361	.165	.....
1879.....	20.67	1.123	.0414	.171	.....
1880.....	20.67	1.145	.0504	.201	.....
1881.....	20.67	1.138	.0481	.181	.....
1882.....	20.67	1.136	.0491	.185	.....
1883.....	20.67	1.11	.0432	.1585	.....
1884.....	20.67	1.13	.0374	.1385	.....
1885.....	20.67	1.065	.0395	.1112	.....
1886.....	20.67	.995	.0463	.11	.....
1887.....	20.67	.978	.0450	.1125	.....
1888.....	20.67	.94	.0442	.1666	.....
1889.....	20.67	.936	.0393	.1375	.....
1890.....	20.67	1.046	.0448	.1575	.....
1891.....	20.67	.988	.0435	.1262	.....
1892.....	20.67	.876	.0409	.1155	.....
1893.....	20.67	.782	.0373	.1075	.....
1894.....	20.67	.63	.0329	.0956	.....
1895.....	20.67	.653	.0323	.1076	.....
1896.....	20.67	.671	.0283	.1088	.....
1897.....	20.67	.5965	.0338	.105	.....
1898.....	20.67	.5825	.0363	.12	.....
1899.....	20.67	.5958	.0447	.1761	.....
1900.....	20.67	.6141	.0473	.1652	.....
1901.....	20.67	.5895	.04334	.16555	.....
1902.....	20.67	.5216	.01069	.11887	\$0.0484
1903.....	20.67	.5345	.04237	.13235	.054
1904.....	20.67	.5722	.043	.12823	.051
1905.....	20.67	.6035	.047	.1559	.0588

AVERAGE MARKET VALUE OF METALS PER ANNUM— CONCLUDED

YEAR	Gold per Ounce	Silver per Ounce	Lead per Pound	Copper per Pound	Zinc per Pound
1906.....	\$20.67	\$0.66791	\$0.05347	\$0.09278	\$0.06198
1907.....	20.67	.654	.0534	.20	.06205
1908.....	20.67	.5284	.0421	.13	.0458
1909.....	20.67	.515	.04273	.121	.055
1910.....	20.67	.5347	.0449	.1263	.0539
1911.....	20.67	.53303	.04465	.12219	.05608
1912.....	20.67	.60835	.04471	.16266	.06799
1913.....	20.67	.59791	.0437	.15194	.0504

Mining Laws and Regulations Relating to Lode and Placer Claims

RULES AND REGULATIONS OF THE UNITED STATES SURVEYOR GENERAL'S OFFICE AND UNITED STATES LAND OFFICE

FEES AND PAYMENTS FOR PATENTING

For lode claim.....	\$30.00
For placer claim.....	35.00
For millsite.....	30.00
For millsite included in one survey with a lode claim.....	20.00
For each lode claim within and included in the survey of a placer claim.....	20.00
For several lode locations included in one survey, the first location named.....	30.00
All other locations named, each.....	25.00
For several placer locations included in one survey, the first location named.....	35.00
All other locations included, each.....	30.00
For affidavit of \$500 expenditure of improvements after approval of survey.....	5.00

PUBLIC LAND FILINGS

All valuable mineral deposits in lands belonging to the United States, both surveyed and unsurveyed, are hereby declared to be free and open to exploration and purchase, and the lands in which they are found, to occupation and purchase by citizens of the United States, and those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners in the several mining districts, so far as the same are applicable and not inconsistent with the laws of the United States. (Rev. Stat. U. S., Sec. 2319.)

LODE CLAIMS

No location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located.

The length of any lode claim may be equal to, but not exceed, 1,500 feet along the vein. The width of lode claims shall be 150 feet on each side of the center of the vein or crevice.

The discoverer of a lode shall, within three months from the date of discovery, record his claim in the office of the recorder of the county in which such lode is situated, by a location certificate.

Before filing such location certificate the discoverer shall locate his claim: (1) By sinking a discovery shaft upon the lode

to the depth of at least ten feet from the lowest part of the rim of such shaft at the surface, or deeper if necessary to show a well-defined crevice. (2) By posting at the point of discovery on the surface a plain sign or notice, containing the name of the lode, the name of the locator and the date of discovery. (3) The discoverer shall have sixty days from the time of uncovering or disclosing a lode to sink a discovery shaft thereon.

On each claim located, and until a patent has been issued therefor, not less than \$100.00 worth of labor shall be performed or improvements made during each year. The period within which the work required to be done annually on all unpatented mineral claims shall commence on the first day of January succeeding the date of location of such claim.

Marking boundaries—posts, piles of stones.—Such surface boundaries shall be marked by six substantial posts hewed or marked on the side or sides which are in toward the claim, and sunk in the ground, to-wit: one at each corner and one at the center of each side line. Where it is practically impossible on account of bed-rock to sink such posts, they may be placed in a pile of stones, and where in marking the surface boundaries of a claim any one or more of such posts shall fall by right upon precipitous ground, where the proper placing of it is impracticable or dangerous to life or limb, it shall be legal and valid to place any such post at the nearest practicable point, suitably marked, to designate the proper place.

Open cut, cross-cut, tunnel, adit, to hold lode.—Any open cut, cross-cut or tunnel which shall cut a lode at a depth of ten feet below the surface, shall hold such lode, the same as if a discovery shaft were sunk thereon, or an adit of at least ten feet in along the lode from the point where the lode may be in any manner discovered, shall be equivalent to a discovery shaft.

Sixty days to sink discovery shaft.—The discoverer shall have sixty days from the time of uncovering or disclosing a lode to sink a discovery shaft thereon.

What location includes; extralateral rights.—The location or location certificate of any lode claim shall be construed to include all surface ground within the surface lines thereof, and all lodes and ledges throughout their entire depth, the top or apex of which lies inside of such lines extended downward, vertically, with such parts of all lodes or ledges as continue by dip beyond the side lines of the claim, but shall not include any portion of such lodes or ledges beyond the end lines of the claim, or the end lines continued, whether by dip or otherwise, or beyond the side lines in any other manner than by the dip of the lode.

PLACERS

All placer mining claims shall conform as near as practicable with the United States system of public land surveys, and no such location shall include more than twenty acres for each individual claimant.

Claims usually called "placers," including all forms of deposits, excepting veins of quartz or other rock in place, shall be subject to entry and patent under like circumstances and conditions, and upon similar proceedings, as provided for vein or lode claims.

Location certificate; recording; manner of locating.—The discoverer of a placer claim shall, within thirty days from the date of discovery, record his claim in the office of the recorder of the county in which said claim is situated, by a location certificate, which shall contain: first, the name of the claim, designating it as a placer claim; second, the name of the locator; third, the date of location; fourth, the number of acres or feet claimed; and, fifth, a description of the claim, by such reference to natural objects or permanent monuments as shall identify the claim. Before filing such location certificate the discoverer shall locate his claim, first, by posting upon such claim a plain sign or notice, containing the name of the claim, the name of the locator, the date of discovery, and the number of acres or feet claimed; second, by marking the surface boundaries with substantial posts, and sunk into the ground, to-wit, one at each angle of the claim.

Size of claims.—Legal subdivisions of forty acres may be subdivided into ten-acre tracts; and two or more persons or associations of persons, having contiguous claims of any size, although such claims may be less than ten acres each, may make joint entry thereof; but no location of a placer claim made after the ninth day of July, eighteen hundred and seventy, shall exceed one hundred and sixty acres for any one person or association of persons, which location shall conform to the United States surveys; and nothing in this section contained shall defeat or impair any bona fide pre-emption or homestead claim upon agricultural lands, or authorize the sale of the improvements of any bona fide settler to any purchaser.

Twenty acres to one locator.—Where placer claims are upon surveyed lands, and conform to legal subdivisions, no further survey or plat shall be required, and all placer mining claims located after the tenth day of May, eighteen hundred and seventy-two, shall conform as near as practicable with the United States system of public land surveys and rectangular subdivisions of such surveys, and no such location shall include more than twenty acres for each individual claimant; but where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands; and where, by the segregation of mineral land in any legal subdivision, a quantity of agricultural land less than forty acres remains, said fractional portion of agricultural land may be entered by any party qualified by law for homestead or pre-emption purposes.

Claim intersected by lode.—Where the same person, association or corporation is in possession of a placer claim, and also a vein or lode included within the boundaries thereof, application shall be made for a patent for the placer claim, with the statement

that it includes such vein or lode, and in such case a patent shall issue for the placer claim, subject to the provisions of this chapter, including such vein or lode, upon the payment of five dollars per acre for such vein or lode claim, and twenty-five feet of surface on each side thereof. The remainder of the placer claim, or any placer claim not embracing any vein or lode claim, shall be paid for at the rate of two dollars and fifty cents per acre, together with all costs of proceedings; and where a vein or lode, such as is described in section 2320, is known to exist within the boundaries of a placer claim, an application for a patent for such placer claim which does not include an application for the vein or lode claim shall be construed as a conclusive declaration that the claimant of the placer claim has no right of possession of the vein or lode claim; but where the existence of a vein or lode in a placer claim is not known, a patent for the placer claim shall convey all valuable mineral and other deposits within the boundaries thereof.

Location and location certificate.—The discoverer of a placer claim shall, within thirty days from the date of discovery, record his claim in the office of the recorder of the county in which said claim is situated, by a Location Certificate which shall contain: first, the name of the claim, designating it as a placer claim; second, the name of the locator; third, the date of location; fourth, the number of acres or feet claimed; and, fifth, a description of the claim by such reference to natural objects or permanent monuments as shall identify the claim.

Before filing such location certificate, the discoverer shall locate his claim: first, by posting upon such claim a plain sign or notice, containing the name of the claim, the name of the locator, the date of discovery, and the number of acres or feet claimed; second, by marking the surface boundaries with substantial posts, and sunk in the ground, to wit, one at each angle of the claim. (1879.)

Annual labor.—On each placer claim of one hundred and sixty acres or more, heretofore or hereafter located, and until a patent has been issued therefor, not less than one hundred dollars' worth of labor shall be performed or improvements made by the first day of August, 1879, and by the first day of August of each year thereafter. On all placer claims containing less than one hundred and sixty acres the expenditure during each year shall be such proportion of one hundred dollars as the number of acres bears to one hundred and sixty. On all placer claims containing less than twenty acres the expenditures during each year shall not be less than twelve dollars; but when two or more claims lie contiguous, and are owned by the same person, the expenditure hereby required for each claim may be made on any one claim, and upon a failure to comply with these conditions, the claim or claims upon which such failure occurred shall be open to relocation, in the same manner as if no location of the same had ever been made; provided, that the original locators, their heirs, assigns or legal representatives, have not resumed work upon the claim after

failure and before such location; provided the aforesaid expenditures may be made in building or repairing ditches to conduct water upon such ground, or in making other mining improvements necessary for the working of such claim.

Upon the failure of any one of several co-owners to contribute his proportion of the expenditures required hereby, the co-owners who have performed the labor, or made the improvements, may at the expiration of the year, to wit, the first of August, 1879, for the locations heretofore made, and one year from the date of locations hereafter made, give such delinquent co-owner personal notice in writing, or, if he be a non-resident of the State, a notice by publication in the newspaper published nearest the claim for at least once a week for ninety days, and mailing him a copy of such newspaper if his address be known, and if at the expiration of ninety days after such notice in writing, or after the first publication of such notice, such delinquent should fail or refuse to contribute his proportion of the expenditure required by this section, his interest in the claim shall become the property of his co-owners who have made the required expenditures. (1879.)

TUNNELS

Any person or persons engaged in working a tunnel, within the provisions of this chapter, shall be entitled to 250 feet each way from said tunnel, on each lode so discovered; provided, they do not interfere with any vested rights. If it shall appear that claims have been staked off and recorded prior to the record of said tunnel, on the line thereof, so that the required number of feet cannot be taken near said tunnel, they may be taken upon any part thereof where the same may be found vacant; and persons working said tunnel shall have the right of way through all lodes which may lie in its course.

Where a tunnel is run for the development of a vein or lode, or for the discovery of mines, the owners of such tunnel shall have the right of possession of all veins or lodes within 3,000 feet from the face of such tunnel on the line thereof not previously known to exist, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface made by other parties after the commencement of the tunnel, and while the same is being prosecuted with reasonable diligence, shall be invalid; but failure to prosecute the work on the tunnel for six months shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel.

Where a person or company has or may run a tunnel for the purpose of developing a lode or lodes owned by said persons or company, the money so expended on said tunnel shall be taken and considered as expended on said lode or lodes, and such person or company shall not be required to perform work on the surface of said lode or lodes in order to hold the same.

AFFIDAVIT OF ANNUAL LABOR—EFFECT OF FILING

Within six months after any time set or annual period allowed for the performance of labor or making improvements upon any lode claim or placer claim, the person on whose behalf such outlay was made, or some person for him, may make and record in the office of the recorder of the county wherein such claim is situate, an affidavit in substance as follows:

State of Colorado, County, ss.

Before me, the subscriber, personally appeared..... who, being duly sworn, saith that at least..... dollars' worth of work or improvements were performed or made upon (here describe claim or part of claim), situate in..... mining district, County of....., State of Colorado, between the.....day of.....A. D., and the.....day of.....A. D. Such expenditure was made by or at the expense of....., owners of said claim, for the purpose of complying with the law, and holding said claim.

Jurat: (Signature).....

And such affidavit, when so recorded, shall be prima facie evidence of the performance of such labor or the making of such improvements; Provided, That all affidavits of labor or improvements upon placer claims heretofore filed and recorded within the period prescribed in this section, or within the period prescribed in section twenty-four hundred and ten of the General Statutes, which shall contain in substance the requirements of the affidavit prescribed by this section or said section twenty-four hundred and ten, shall be prima facie evidence of the performance of such labor or the making of such improvements; and the original thereof, or a certified copy of the record of the same, shall be received as evidence accordingly by the courts of this state, and this class of evidence shall be receivable, where relevant or material, in all causes, whether now pending or hereafter brought.

RE-LOCATION BY OWNER—CONDITIONS

If at any time the locator of any mining claim heretofore or hereafter located, or his assigns, shall apprehend that his original certificate was defective, erroneous, or that the requirements of the law had not been complied with before filing, or shall be desirous of changing his surface boundaries, or of taking in any part of an overlapping claim which has been abandoned, or in case the original certificate was made prior to the passage of this law, and he shall be desirous of securing the benefits of this act, such locator, or his assigns, may file an additional certificate, subject to the provisions of this act; Provided, That such re-location does not interfere with the existing rights of others at the time of such re-location, and no such re-location or other record thereof shall preclude the claimant or claimants from proving any such title or titles as he or they may have held under previous location.

RE-LOCATION OF ABANDONED LODES

The re-location of abandoned lode claims shall be by sinking a new discovery shaft and fixing new boundaries in the same manner as if it were the location of a new claim; or the re-locator may sink the original discovery shaft ten feet deeper than it was at the time of the abandonment, and erect new or adopt the old boundaries, renewing the posts if removed or destroyed. In either case a new location stake shall be erected. In any case, whether the whole or part of an abandoned claim is taken, location certificate may state that the whole or any part of the new location is located as abandoned property.

PATENT

A patent for any land claimed and located for valuable deposits may be obtained in the following manner: Any person, association or corporation having claimed and located a piece of land for such purposes, may file in the proper land office an application for a patent, together with a plat and field notes of the claim or claims in common, made by or under the direction of the United States Surveyor-General, and shall thereupon be entitled to a patent for the land in the manner following: The register of the land office, upon the filing of such application, shall publish a notice that such application has been made, for the period of sixty days, in a newspaper to be by him designated as published nearest to such claim; and he shall also post such notice in his office for the same period. The claimant shall file with the register a certificate of the United States Surveyor-General that \$500.00 worth of labor has been expended or improvements made upon the claim. At the expiration of the sixty days of publication, the applicant is entitled to a patent, upon the payment to the proper officer of \$5.00 per acre.

Altitude of Cities and Towns in Colorado

Name	Feet	Name	Feet
Alamosa.....	7,536	Las Animas.....	3,884
Alma.....	10,238	Leadville.....	10,190
Anaconda.....	9,453	Littleton.....	5,358
Antonito.....	7,876	Longmont.....	4,941
Aspen.....	7,943	Loveland.....	4,986
Berthoud.....	4,962	Lyons.....	5,349
Black Hawk.....	8,045	Mancos.....	6,996
Boulder.....	5,350	Manitou Springs.....	6,307
Breckenridge.....	9,534	Manzanola.....	4,240
Buena Vista.....	7,958	Meeker.....	6,182
Canon City.....	5,332	Monte Vista.....	7,653
Central City.....	8,516	Montrose.....	5,801
Colorado City.....	6,077	New Castle.....	5,552
Colorado Springs.....	5,878	Ouray.....	7,710
Como.....	9,785	Pagosa Springs.....	7,095
Creede.....	8,850	Palmer Lake.....	7,224
Cripple Creek.....	9,591	Pitkin.....	9,190
Del Norte.....	7,868	Pueblo.....	4,675
Deita.....	4,970	Red Cliff.....	8,598
Denver.....	5,184	Rico.....	8,725
Dillon.....	8,849	Ridgway.....	6,993
Dolores.....	6,945	Robinson.....	10,857
Durango.....	6,508	Rocky Ford.....	4,176
Fairplay.....	9,896	Saguache.....	7,745
Florence.....	5,187	Salida.....	7,038
Fort Collins.....	4,984	San Luis.....	7,946
Georgetown.....	8,507	Silver Plume.....	9,189
Glenwood Springs.....	5,747	Silverton.....	9,288
Golden.....	5,693	Starkville.....	6,337
Grand Junction.....	4,573	Steamboat Springs.....	6,781
Greeley.....	4,652	Sterling.....	3,932
Gunnison.....	7,673	Telluride.....	8,744
Idaho Springs.....	7,556	Trinidad.....	5,985
Lafayette.....	5,094	Victor.....	9,728
La Junta.....	4,052	Walsenburg.....	6,187
Lamar.....	3,610	Wray.....	3,531
Lake City.....	8,675	Yuma.....	4,147

Elevation of Mountain Peaks and Passes in Colorado

Name	Feet	Name	Feet
Agency Knob.....	12,274	Calico Peak.....	12,056
Alpine Tunnel.....	11,606	Cameron Cone.....	10,685
Anchor Mountain.....	12,092	Canby, Mount.....	13,466
Antelope Pass.....	8,050	Capitol Mountain.....	13,997
Antero, Mount.....	14,245	Carbon Mountain.....	12,000
Arapahoe Peak.....	13,520	Cascade.....	11,707
Argentine Pass.....	13,286	Castle Peak.....	14,259
Arkansas, Mount.....	13,807	Cement Mountain.....	12,212
Augusta Mountain.....	12,615	Chama Peak.....	12,248
Avery Peak.....	12,659	Cheyenne.....	9,407
Axtell Mountain.....	12,012	Chicago Lake.....	11,500
Bald Mountain, Boulder Co.....	11,493	Chief Mountain.....	11,710
Bald Mountain, Larimer Co.....	11,270	Clark's Peak.....	13,167
Bald Mountain, Summit Co.....	13,974	Cochetopa Dome.....	10,000
Bald Mt., San Miguel Co.....	11,700	Conejos Mountain.....	13,183
Baldy, Mount.....	12,809	Corral Peak.....	11,533
Banded Peak.....	12,860	Crested Butte.....	12,172
Battlement Mesa, Mead.....	12,000	Crestone Peak.....	14,233
Basalt Peak.....	11,906	Culebra Peak.....	14,069
Bear Mountain.....	12,950	Cunningham Pass.....	12,090
Beekwith Mountain.....	12,371	Daly, Mount.....	13,193
Belle View.....	12,673	Del Norte.....	13,084
Bellvue.....	12,350	Double Top Mountain.....	12,192
Beson Peak.....	12,426	Eagle Peak.....	12,105
Blackhawk.....	12,677	East Cement Mountain.....	12,047
Blackhead.....	12,514	East Spanish Peak.....	12,708
Blaine, Mount.....	14,249	Elbert.....	14,421
Blanca Peak.....	14,390	Elk Mountain.....	12,718
Boreas.....	11,480	Engineer Mountain.....	13,190
Boulder Pass.....	11,670	Elliott Mountain.....	12,337
Boulder Peak.....	12,417	Emmons, Mount.....	12,414
Breckenridge Pass.....	11,503	Eolus, Mount.....	14,079
Buckeye Peak.....	12,873	Ethel Peak.....	11,976
Buckskin Mountain.....	14,296	Evans, Mount.....	14,321
Buffalo Peak.....	13,541	Farnum Peak.....	11,400

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet	Name	Feet
Flora, Mount.....	12,878	Horsefly Peak.....	10,504
Freeman Peak.....	11,627	Horseshoe Mountain.....	13,912
Fremont Pass.....	11,320	Humboldt Peak.....	14,044
Frustum Mountain.....	13,893	Hunchback Mountain.....	13,133
Galena Mountain.....	13,290	Hunt's Peak.....	12,446
Garfield, Mount.....	13,065	Hurricane Peak.....	13,565
Georgia Pass.....	11,476	Iron Mountain.....	10,405
Gibson Peak.....	13,729	Jacque Peak.....	13,215
Gilpin Peak.....	13,682	James Peak.....	13,283
Glacier Peak.....	12,654	Johnny Bull Mountain.....	12,018
Golden Peak.....	9,650	Jones Mountain.....	13,851
Gothic Mountain.....	12,646	Jupiter Peak.....	13,830
Grand Mesa.....	10,000	Kendall, Mount.....	13,480
Grayback Peak.....	12,387	Kenosha Cone, East.....	12,350
Gray Head Summit.....	10,994	Kenosha Cone, West.....	12,340
Gray's Peak.....	14,341	Keyes, Mount.....	13,750
Greenhorn Mountain.....	12,334	Kit Carson Peak.....	14,100
Green Mountain.....	10,530	Lake Creek Pass.....	12,226
Griffith Mountain.....	11,427	Lamborn, Mount.....	11,337
Grizzly Peak, San Juan.....	13,748	La Plata Peak.....	14,342
Grizzly Peak, Pitkin.....	13,956	La Veta Peak.....	11,000
Gunnison, Mount.....	12,688	Leavenworth Mountain.....	10,390
Guyot Mountain.....	13,565	Leviathan Peak.....	13,528
Hagerman.....	11,495	Leon Peak.....	10,954
Hague.....	13,832	Lilie Mountain.....	11,433
Hamilton, Mount.....	13,800	Lincoln, Mount.....	14,297
Hancock Pass.....	12,263	Little Lone Cone.....	12,001
Handie's Peak.....	14,008	Lizard Head.....	13,156
Hanby Peak.....	10,906	Lone Cone.....	12,761
Harvard, Mount.....	14,375	Long's Peak.....	14,271
Hayden Divide.....	9,182	Lookout Peak.....	13,674
Hayden Pass.....	10,780	Lost Park Mountain.....	11,800
Helmet Peak.....	11,976	Loveland Pass.....	11,876
Hermosa, Mount.....	12,564	McClellan, Mount.....	13,423
Hesperus Peak.....	13,225	McMillan Peak.....	12,800
Holy Cross, Mount of.....	14,170	Macomb Peak.....	13,154
Homestake Peak.....	13,227	Marcellina, Mount.....	11,349
Hoosier Pass.....	10,309	Marmot Peak.....	11,841

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet	Name	Feet
Maroon Peak.....	14,126	Pisgah, Mount.....	10,322
Marshall Pass.....	10,846	Plateau Peak.....	12,030
Marvine, Mount.....	12,045	Pole Creek Mountain.....	13,400
Massive, Mount.....	14,424	Poncha Pass.....	9,049
Matterhorn Peak.....	13,589	Pope's Nose.....	12,271
Mears Peak.....	13,008	Potosi Peak.....	13,763
Mesa Peak.....	12,581	Powell, Mount.....	13,398
Mesquite Pass.....	13,308	Princeton, Mount.....	14,196
Mineral Creek Pass.....	11,098	Prospect Mountain.....	12,618
Mineral Point.....	12,541	Ptarmigan Hill.....	12,174
Monitor Peak.....	13,703	Ptarmigan Peak.....	13,746
Mosca Pass.....	9,713	Purgatory Peak.....	13,749
Mosquito Peak.....	13,794	Pyramid Peak.....	13,885
Muddy Creek Pass.....	8,772	Quandry Peak.....	14,266
Nebo, Mount.....	13,192	Rabbit's Ears Mountains.....	10,719
North Italian Mountain.....	13,225	Ragged Mountain.....	12,481
North Main.....	10,973	Ralston Butte.....	10,593
North Sheep Mountain.....	12,439	Raspberry Mountain.....	10,500
Ohio Peak.....	12,251	Raton Pass.....	7,893
Ohio Pass.....	10,033	Red Cloud Peak.....	14,050
Old Baldy.....	14,176	Red Mountain.....	13,333
Ormus Mountain.....	12,185	Republican Mountain.....	13,393
Oso, Mount.....	13,640	Rhyolite Mountain.....	10,775
Ouray, Mount.....	13,956	Richmond Mountain.....	12,543
Owen, Mount.....	13,102	Rio Grande Pyramid.....	13,773
Pagoda Peak.....	11,257	Rito Alto.....	12,989
Pagosa Peak.....	12,674	Rolling Mountain.....	13,694
Park Conc.....	12,021	Rosa, Mount.....	11,427
Parrott Peak.....	11,876	Rosalie, Mount.....	13,575
Parry Peak.....	13,133	Round Mountain, Elk.....	10,881
Pass Mountain.....	11,200	Round Mountain, San Juan.....	13,122
Pearl Mountain.....	13,484	Rowtner, Mount.....	13,750
Pearl Pass.....	12,715	Ruby Peak.....	12,749
Peeler Peak.....	12,219	Saddle Mountain.....	10,815
Pigeon Peak.....	13,961	San Bernardo Mountain.....	11,845
Pike's Peak.....	14,107	San Francisco Pass.....	8,560
Pike's Peak Timberline.....	11,720	Sangre de Cristo Pass.....	9,459
Pilot Knob.....	13,750	San Luis Peak.....	14,100

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet	Name	Feet
Schuykill Mountain.....	12,188	Telescope Mountain.....	12,231
Searight Mountain.....	11,333	Ten Mile Peak.....	12,800
Sharano Peak.....	14,239	Teocalli Mountain.....	13,220
Sheep Mountain, Chaffee Co....	12,447	Tetons Mountain.....	14,198
Sheep Mountain, Elk Mts.....	13,180	Tilton Mountain.....	12,633
Sheep Mtn., Huerfano Co.....	10,600	Tomichi Dome.....	11,384
Sheep Mountain, Summit Co....	12,380	Torrey Peak.....	14,336
Sheridan Mountain, Park Co....	14,038	Tower Mountain.....	13,444
Sheridan Mtn., San Juan Co....	12,785	Trachyle Mountain.....	10,876
Sherman Mountain.....	14,048	Treasury Mountain.....	13,200
Signal Butte.....	9,300	Trinchera Mountain.....	13,546
Silex, Mount.....	13,687		13,752
Silver Hill.....	13,880	Trinity Peaks.....	13,804
Silver Heels, Mount.....	13,835		13,745
Simpson, Mount.....	14,055	Troublesome Peak.....	11,500
Slate Peak.....	12,989	Trout Creek Pass.....	9,346
Sneffels, Mount.....	14,158	Turret Peak.....	13,819
Snowmass Mountain.....	13,970	Twilight Peak.....	13,153
Sockrider Peak.....	12,315	Twin Cones.....	12,400
Sopris, Mount.....	12,823	Twin Sisters.....	13,438
South River Peak.....	13,160	Uncompahgre Peak.....	14,289
Spanish Peaks.....	13,620, 12,708	Union Mountain.....	12,336
Squaw Mountain, Teller Co.....	10,376	Ute Peak.....	11,968
Squaw Mtn., Front Range.....	13,093	Vasquez Peak.....	12,658
Star Peak.....	13,562	Velie Peak.....	13,456
Stewart Peak.....	14,032	Venado Peak.....	12,800
Stoll Mountain.....	10,915	Vermillion Peak.....	13,870
Stony Mountain.....	12,677	Vestal Peak.....	13,846
Storm King.....	13,742	Veta Pass.....	9,378
Stormy Peak.....	11,748	Virginia Peak.....	10,600
Storm Ridge.....	11,859	Vulcan Crest.....	13,971
Sultan Mountain.....	13,336	Wasatch Mountain.....	13,551
Summit Peak.....	13,323	Weminuche Pass.....	10,622
Sunlight Mountain.....	14,053	West Elk Peak.....	12,920
Sunshine Mountain.....	12,945	Weston Pass.....	12,109
Tarryall Pass.....	12,456	West Spanish Peak.....	13,623
Tarryall Peak.....	11,300	Wetterhorn.....	14,092
Taylor Peak.....	13,419	Wheatstone Mountain.....	12,548

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Concluded

Name	Feet	Name	Feet
White Dome.....	13,607	Wilson, Mount.....	14,250
White Face Peak.....	11,494	Windom Mountain.....	14,084
Whitehead Peak.....	10,817	Wood Mountain.....	13,640
Whitehouse Mountain.....	13,496	Yale, Mount.....	14,187
White Rock Mountain.....	13,532	Yampa Peak.....	8,022
Wild Horse Peak.....	13,271	Yellow Jacket Pass.....	7,493
Wilkinson, Mount.....	11,687	Yellow Peak.....	13,618
Williams Peak.....	11,413	Zenobia Peak.....	9,297
Willow Creek Pass.....	9,683	Zirkel, Mount.....	12,126

Elevation of Parks and Lakes

Name	Feet	Name	Feet
Allen Park.....	8,513	Manitou Park.....	8,464
Bergen Park.....	7,543	Middle Park (Mean).....	7,500
Big Lake (San Luis Valley).....	7,478	North Park (Mean).....	8,500
Brennan Lake.....	10,325	San Cristoval Lake.....	9,000
Buffalo Springs (South Park)....	8,901	San Luis Valley (Mean).....	7,500
Chicago Lake.....	11,500	San Luis Lake.....	7,592
Columbine Lake.....	8,788	San Miguel Lake.....	9,720
Crater Lake.....	8,877	Sheridan Lake.....	4,065
Crane Park.....	10,102	South Park.....	8,000 to 10,000
Crystal Park.....	9,317	Trout Lake.....	9,700
Eagle Park.....	9,212	Twin Lakes.....	9,012
Elk Park.....	8,868	Twin Sister Lake.....	13,438
Grand Lake.....	8,153	Union Park.....	9,655
Hughes Lake.....	7,453	Weiserhorn Lake.....	5,238
Jerome Park.....	8,290	White River Plateau....	11,000 to 12,000
Lake Moraine.....	10,268		

Population of Colorado

FROM 1860 TO 1910, BY DECADES

CENSUS YEARS	POPULATION	INCREASE	
		Number	Per Cent
1860.....	34,277	.....	....
1870.....	39,864	5,587	16.2
1880.....	194,327	154,463	387.4
1890.....	413,249	218,922	112.1
1900.....	539,700	126,451	30.9
1910.....	799,024	259,324	48.1

Gold Strike Cresson Mine

This report had gone to the printer when announcement was made of a great gold strike in the Cresson Mine, operated by the Cresson Consolidated Gold Mining Company at Cripple Creek. While the report covers only the period ending November 30, 1914, this strike was of sufficient importance to warrant the insertion of a brief mention as a supplement.

In December, 1914, a vug was located in the Cresson Mine 1,265 feet below the surface. The vug was in the shape of a pear, its dimensions being $33\frac{1}{2}$ feet in length, $14\frac{1}{2}$ feet in width, and 36 feet in height. The walls were lined with calaverite and sylvanite. It was the greatest strike of its kind ever made in a gold mine. The amount of gold that the vug will produce cannot be accurately estimated until the thickness of the walls has been determined.

The discovery of this vug is a proof of the contention of the Cripple Creek miners that the richness of the ores continues to an unknown depth.

Further proof of this is established by the discovery of very rich ore on the seventeenth, eighteenth, and nineteenth levels of three mines in the Cripple Creek district. The greatest depth attained in Cripple Creek is 1,900 feet, and the richness of the ore continues.

The strike in the Cresson and the other discoveries at great depth have awakened a new interest in the Cripple Creek district. There was a big demand for properties and leases at the close of the year.

INDEX

INDEX

	Page
Accidents.....	184
Accidents per men employed.....	190
Accidents—tables.....	186
Acid manufacture.....	150
Agate.....	132
Altitude, cities and towns.....	215
Altitude, parks and lakes.....	220
Altitude, peaks and passes.....	216
Amazonite.....	132
Amethyst.....	132
Aquamarine.....	134
Argo Mill.....	90
Argo Tunnel.....	111
Arkansas Valley Ry. Lt. & P. Co.....	57
Asphalt.....	149
Atlas Mill.....	71
Bald Mountain District.....	37
Barstow Mill.....	91
Big Five Tunnel.....	19
Boulder County.....	20
Boulder County Districts.....	177
Boulder County Tungsten.....	127
Bureau of Mines.....	172
Carnotite.....	117
Carnotite, capital employed.....	125
Carnotite, companies operating.....	124
Carnotite, development.....	125
Carnotite, future.....	126
Carnotite, mills.....	125
Carnotite, mining claims.....	124
Carnotite, production.....	125
Carter Mill.....	96
Cement.....	146
Chaffee County.....	32
Chaffee County, districts.....	177
Chaffee County, mica.....	135
Chalcedony.....	133
Clays.....	148
Clear Creek County.....	17
Clear Creek County, districts.....	177
Code of signals.....	198
Coal.....	7
Colburn-Ajax Mill.....	75
Colorado Metal Mining Association.....	159
Colorado mining epitomized.....	156
Colorado Power Company.....	52
Conejos County.....	10, 28, 43
Conejos County, districts.....	177
Conservation.....	152, 117
Costilla County, districts.....	178
Custer County.....	29
Custer County, districts.....	178
Cyanide process, see mills.	
Districts, location of.....	5
Dolores County.....	50

	Page
Dolores County, districts.....	178
"Don'ts".....	196
Drainage.....	60
Dredging.....	35, 128
Eagle Camp.....	10
Eagle County.....	31
Eagle County, districts.....	178
Electricity and Mining.....	52
El Paso County.....	30
Empire Gulch district.....	39
Empire Zinc Plant.....	100
Epidote.....	134
Experimental Plant of United States.....	164
Experiment Stations.....	171
Facts on Colorado mining.....	156
Financial statement.....	199
Fluorspar.....	22
Forests, above timberline.....	154
Forestry Service.....	163
Foreword.....	7
Freight rates.....	164
Fremont County.....	30
Fremont County, districts.....	178
Funds of Bureau of Mines.....	172
Garnet.....	134
Gems.....	132
Geology of Colorado.....	173
Geological folios.....	176
Geological survey (state).....	165
Gilpin County.....	13
Gilpin County, districts.....	178
Gilsonite.....	149
Gold dredging.....	128
Golden Cycle Mill.....	72
Grand County.....	24
Grand County, districts.....	179
Granite, Gunnison County.....	145
Granite, Salida.....	140
Grindstone.....	145
Gunnison County.....	44
Gunnison County, districts.....	179
Gunnison County, granite.....	145
Gunnison County, marble.....	142
Hinsdale County.....	49
Hinsdale County, districts.....	179
Home pools and leasing.....	163
Huerfano County, districts.....	179
Jackson County, districts.....	179
Jasper.....	133
Jefferson County, districts.....	179
Labor troubles.....	183
Lake County.....	35
Lake County, districts.....	179
Land withdrawal.....	117
La Plata County.....	49
La Plata County, districts.....	179
Larimer County, districts.....	179

	Page
Laws on mining.....	170, 208
Leasing public domain.....	120-152
Legislation.....	166
Letter of transmittal.....	6
Liberty Bell Mine.....	102
Limestone.....	145
Location of claims.....	208
Lombard Mill.....	91
Manufacturing.....	9
Marble, Colorado-Yule.....	142
Mary Murphy Mill.....	65
Mask Mill (mining).....	78
Men employed in (mining) milling and smelting.....	188
Mesa County, districts.....	180
Metals, prices of.....	8
Metal production, 1913.....	200
Metal production 1914.....	202
Metal production, total.....	204
Mica, mining and milling.....	135
Mills (see review Districts 1, 2, 3, 4; also table of contents)	
Mineral County.....	42
Mineral County, districts.....	180
Mineral waters.....	7
Mineral wealth, Colorado.....	170
Mines, names and locations of large (see reviews Districts 1, 2, 3, 4)	
Mining districts.....	164
Mining districts, Colorado.....	177
Mining encouragement.....	168
Mining laws.....	208
Moffat County.....	23
Moffat County, districts.....	181
Molybdenite.....	10
Montezuma County, districts.....	180
Montrose County.....	48
Montrose County, districts.....	180
Mount Champion Mill.....	95
Museum, mineral at State Capitol.....	164-172
Oil.....	7
Ouray County.....	46
Ouray County, districts.....	180
Panama-Pacific Exposition.....	163-170
Park County.....	41
Park County, districts.....	180
Patent on claims.....	210
Personnel.....	5
Pitchblende.....	10
Pitkin County.....	40
Pitkin County, districts.....	180
Population of Colorado.....	221
Portland Mill.....	77
Precious stones.....	132
Primos Mill (Boulder County).....	97
Prospecting.....	9
Publicity for mining.....	164
Pueblo County, districts.....	181
Pueblo County, sandstone.....	145
Quartz.....	132
Quartz (rose, smoky and clear).....	133

	Page
Radium.....	9
Radium, history of.....	122
Radium, industry.....	9, 117
Radium lands, withdrawal.....	162
Radium mill.....	113
Radium, price of.....	119
Radium, uses of.....	123
Recommendations for safety.....	191
Review—1913-1914.....	8
Review—District No. 1.....	13
Review—District No. 2.....	26
Review—District No. 3.....	31
Review—District No. 4.....	42
Rio Blanco County, districts.....	181
Rio Grande County.....	28, 29
Rio Grande County, districts.....	181
Routt County.....	22
Routt County, districts.....	181
Safety stations.....	171
Saguache County.....	42
Saguache County, districts.....	182
Salida Lt. Power & Utility Co.....	56
Sandstone, Turkey Creek.....	145
San Juan County.....	45
San Juan County, districts.....	182
San Miguel County.....	47
San Miguel County, districts.....	182
Santiago Tunnel.....	20
Sardius.....	134
School of Mines, experimental plant.....	62
Smelters.....	11
Smuggler Mill.....	104
Smuggler Union Mill.....	98
Stone Resources.....	145
Stratton's Independence Mill.....	80
Summit County.....	33
Summit County, districts.....	182
Summit County, dredging (see also review District No. 3).....	128
Taxation of Mines.....	162-166
Teller County.....	26
Teller County, districts.....	182
Topaz.....	134
Tungsten.....	22, 127
Tungsten (see Boulder County, review District No. 1).....	
Tungsten mill.....	97
Tungsten, prices of.....	127
Tungsten, production.....	127
Tunnels.....	19
United States Geological Survey Publications.....	173
Value of Metals (average).....	206
War (European), effect of.....	8
Wellington Mill.....	106
Wilcox Tunnel.....	20
Withdrawal radium lands.....	117
Zinc smelter, Leadville.....	38

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24

Report, 1913-1914

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